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BOTHALIA

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Volume 23,2

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Synopsis of the genus *Brachylaena* (Asteraceae) in southern Africa

S.S. CILLIERS*

Keywords: Asteraceae, *Brachylaena*, southern Africa, synopsis, taxonomy

ABSTRACT

A synopsis of the southern African representatives of the genus *Brachylaena* R. Br. (Asteraceae) is presented, in which seven species and two subspecies are recognized. *B. uniflora* Harv. is placed in synonymy with *B. discolor* subsp. *transvaalensis* (Phill. & Schweick.) J. Paiva and the division of subsp. *discolor* in two varieties is not accepted. Descriptions, synonymy, voucher specimens, distribution maps, line drawings and keys to the species and subspecies are given.

UITTREKSEL

'n Sinopsis van die Suider-Afrikaanse verteenwoordigers van die genus *Brachylaena* R. Br. (Asteraceae) word aangebied waarin sewe spesies en twee subspesies erken word. *B. uniflora* Harv. is in sinonimie met *B. discolor* subsp. *transvaalensis* (Phill. & Schweick.) J. Paiva geplaas en die verdeling van subsp. *discolor* in twee variëteite, word nie aanvaar nie. Beskrywings, sinonimie, verwysingseksempelare, verspreidingskaarte, lyndiagramme en sleutels tot die spesies en subspesies word voorsien.

INTRODUCTION

The latest taxonomic revision of all southern African species of *Brachylaena* was published by Phillips & Schweickerdt (1937). They recognized nine species in South Africa, including a new species, *B. transvaalensis* Phill. & Schweick., as well as *B. discolor* DC. and *B. uniflora* Harv.

According to Hilliard & Burt (1971) it is not always possible to distinguish between *B. discolor*, *B. uniflora* and *B. transvaalensis* on the basis of the characters described by Phillips & Schweickerdt (1937). These three species became known as the *B. discolor-uniflora* complex, which was regarded as the only remaining taxonomic problem in the genus.

In an effort to solve that problem, Paiva (1972) reduced *B. transvaalensis* to subspecific rank, under *B. discolor*. He also distinguished two varieties (var. *mossambicensis* and var. *discolor*) in *B. discolor* subsp. *discolor* on the basis of reproductive characteristics. Unfortunately he did not study *B. uniflora* because it does not occur in his study area, namely that of the *Flora zambesiaca*.

Hilliard (1977) did not agree with Paiva (1972) and speculated that *B. discolor* and *B. uniflora* represented merely the extremes in a wide range of head sizes within the *B. discolor-uniflora* complex. According to Hilliard (1977) the variation of the characteristics used by Paiva (1972) as diagnostic, is continuous. Hilliard also mentioned that the variation can be interpreted in two ways: a single species showing clinal variation in the number of flowers in a head loosely linked to an ecological cline, or two species which are hybridizing.

Gibbs Russell *et al.* (1987) followed the delimitation proposed by Paiva (1972), and recognized eight species and four infraspecific taxa in southern Africa, including *B. discolor* DC. subsp. *discolor* with the varieties *discolor* and *mossambicensis* J. Paiva; subsp. *transvaalensis* (Phill. & Schweick.) J. Paiva; as well as *B. uniflora* Harv.

The views presented here are supported by a detailed study of the vegetative and reproductive morphology and the anatomy of leaves and stems of the southern African representatives of *Brachylaena* (Cilliers 1990). Material was gathered during extensive field studies and loaned from all major South African and some overseas herbaria.

A brief review is given of the research on the morphology of the heads of the *B. discolor-uniflora* complex. The variation of certain quantitative characters was presented in the form of dice diagrams (Radford *et al.* 1974) as shown in Figure 1.

The diagrams in Figures 2 & 3 show the following:

- 1, on the basis of four parameters (Figures 2A–C; 3A) the four entities clearly fall into two groups with two members each: a, the varieties of *B. discolor* subsp. *discolor*; and b, *B. discolor* subsp. *transvaalensis* and *B. uniflora*;
- 2, the two varieties of *B. discolor* subsp. *discolor* cannot be separated on the basis of any of the eight parameters;
- 3, on the basis of six of the parameters shown, *B. discolor* subsp. *transvaalensis* and *B. uniflora* cannot be separated; the number of flowers both on male and female heads, however, indicate a discontinuity between the two entities;
- 4, the parameters of the male heads shown are taxonomically more useful than those of the female heads, which tend to show continuous variation; the length of the female involucre, however, clearly supports the recognition of the two groups mentioned under 1.

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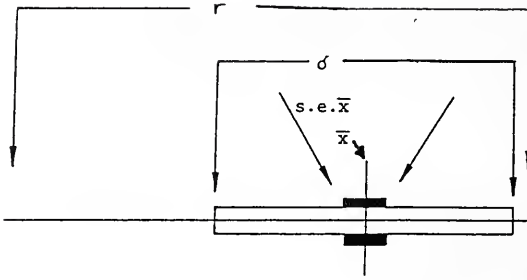


FIGURE 1.—Dice diagram to show variation in certain quantitative characters: where: \bar{x} = mean, $s.e.\bar{x}$ = standard error, σ = standard deviation, and r = range (Radford *et al.* 1974).

On this evidence, backed by other findings by Cilliers (1990), I propose to sink *B. uniflora* under *B. discolor* subsp. *transvaalensis* and not to recognize varieties under *B. discolor* subsp. *discolor*.

TAXONOMIC TREATMENT

Brachylaena R. Br. in Transactions of the Linnean Society of London 12: 115 (1817); DC.: 430 (1836); Harv.: 116 (1865); Benth. & Hook.: 228 (1873); Engl. & Prantl: 174 (1890); Phill. & Schweick.: 206 (1937); Paiva:

368 (1972); Hilliard: 105, 106 (1977). Type species: *B. neriifolia* (L.) R. Br.

Oligocarpa Cass.: 22 (1817).

Trees or shrubs, dioecious. *Leaves* alternate, simple, petiolate or subsessile, entire, toothed or crenate, sometimes 3-lobed at apex, mostly coriaceous, often white- or rusty-tomentose abaxially. *Heads* in open or dense axillary or terminal racemes or panicles, rarely solitary; unisexual, rarely with fertile hermaphrodite flowers; 1–30(–50) flowers per head; involucre oblong, ovoid or campanulate, bracts in 3–7 rows, free, dry, inner ones progressively longer. *Receptacle* epaleate, honeycombed. *Male flowers*: corolla tubular, 3–5-lobed; anthers tailed at base, exserted; style filiform, sometimes thickened above, simple or bifid, branches very short, flat, acute or obtuse; ovary usually abortive, pubescent; pappus poorly developed, of scabrid bristles, uniseriate. *Female flowers*: corolla tubular, 5-lobed; staminodes occasionally present; style filiform, bifid, branches very short, flat, acute or obtuse. *Achenes* 4–5-angled, pubescent or subglabrous, glandular.

The genus consists of twelve species, confined to Africa and the Mascarene Islands. Seven species are found in southern Africa.

KEY TO SPECIES

- 1a Leaves glabrous abaxially, if tomentose then rusty brown; male flowers with an abortive ovary (0.7–1.9 mm long); female flowers with staminodes (0.6–2.0 mm long):
 - 2a Leaf base decurrent into petiole, petiole often up to 8 mm (rarely up to 10 mm) long, not clearly distinct from leaf base; leaf lamina 5–10 (rarely 4) times as long as broad 1. *B. neriifolia*
 - 2b Leaf base acute, petiole mostly longer than 10 mm, clearly distinct from leaf base; leaf lamina 1–4 times as long as broad 2. *B. glabra*
- 1b Leaves white-tomentose abaxially, never glabrous; ovary in male flowers, if present, shorter than 0.6 mm; staminodes in female flowers, if present, shorter than 0.6 mm:
 - 3a Heads in dense axillary racemes or solitary; usually less than six heads per raceme; leaf apex usually mucronate; anthers usually shorter than 1.9 mm:
 - 4a Involucral bracts glabrous to white-tomentulose, in 5–8 series; leaves mostly oblong; petiole up to 3 mm, rarely up to 5 mm long; heads sometimes solitary 3. *B. ilicifolia*
 - 4b Involucral bracts white-tomentose, never glabrous, in 3 or 4, rarely 5 series; leaves mostly obovate to oblanceolate, never oblong; petiole usually longer than 5 mm; heads never solitary 4. *B. huillensis*
 - 3b Heads in open axillary or terminal racemes or panicles; usually more than eight heads per raceme or panicle; leaf apex rarely mucronate; anthers up to 3.7 mm long:
 - 5a Leaf apex 3-lobed or 3-toothed (leaves from coppice growth sometimes without lobes or teeth); involucral bracts in up to 5 series in male heads, in up to 6 series in female heads 5. *B. elliptica*
 - 5b Leaf apex not 3-lobed or 3-toothed; involucral bracts in male heads in 4–10 series, in female heads in 5–10 series:
 - 6a Leaf base obtuse to rounded; leaves mostly elliptic; outer bark dark brown to black 6. *B. rotundata*
 - 6b Leaf base decurrent into a petiole; leaves mostly oblanceolate to narrowly obovate; outer bark light grey or light brown 7. *B. discolor*

1. **Brachylaena neriifolia** (L.) R. Br. in Transactions of the Linnean Society of London 12: 115 (1817); Less.: 208 (1832); DC.: 430 (1836); Drège: 169 (1843); Sch. Bip.: 671 (1844); Harv.: 116 (1865); Bolus & Wolley-Dod 14: 277 (1904); Sim: 246 (1907); Juel: 381 (1918); Sim: 44 (1921); Phill. & Schweick.: 207 (1937). Type: Aethiopia [South Africa], LINN 992.2, lecto.–PRE, photo.!

Baccharis neriifolia L.: 860 (1753); Willd.: 1904 (1804); Pers.: 423 (1807); Spreng.: 462 (1826); Steud.: 178 (1841). *Oligocarpa neriifolia* (L.) Cass.: 22 (1817). *Conyza neriifolia* (L.) L'Hérit. ex Steud.: 414 (1841).

Tarconanthus lanceolatus Thunb.: 145 (1800); Willd.: 1793 (1804); Pers.: 405 (1807); Thunb.: 638 (1823); Spreng.: 456 (1826). Type: Cape, Thunberg s.n. (UPS, holo.–PRE (18917), photo.).

Multistemmed shrubs or small trees (2–4–6(–8) m high; bark dark grey to brown, longitudinally fissured; young branches with rusty brown down, glabrescent. *Leaves* petiolate, oblanceolate to narrowly oblanceolate, sometimes very narrowly elliptic or lorate, (20–)45–110 (–180) × (5–)10–20(–25) mm; coriaceous, glabrous adaxially, glabrous or rusty brown-tomentose abaxially; margins entire or serrated on coppice shoots, base decurrent in a short petiole, rarely acute; petiole (3–)5–8 (–10) mm long. *Heads* many, in open axillary or terminal racemes or panicles; peduncles of male heads 1.5–3.0(–5.0) mm, and of female heads 1.8–3.0 mm long. *Involucral bracts* in 4–7 series, 2.5–3.0(–5.0) × 2.0–3.5(–5.0) mm; individual bracts very narrowly to very broadly ovate, or narrowly to widely elliptic, rusty brown. *Flowers* 8–13 in

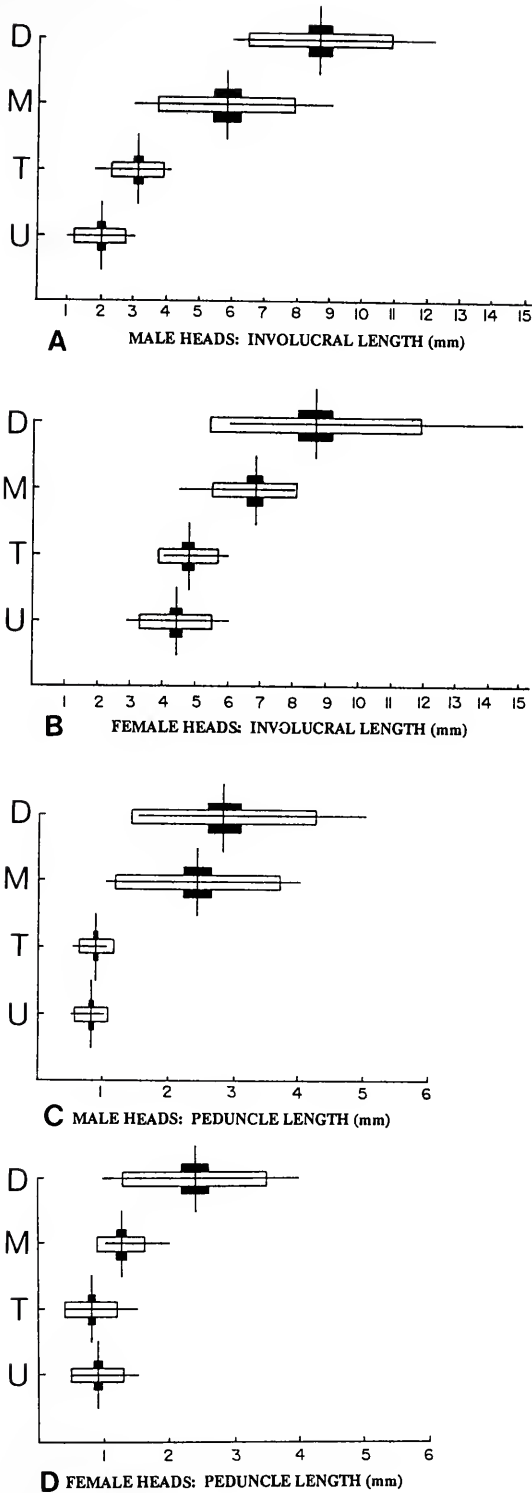


FIGURE 2.—Dice diagrams of all studied material of the *B. discolor-uniflora* complex. Variation in involucral length (mm): A, male, and B, female heads; variation in peduncle length (mm) of C, male and D, female heads. D = *B. discolor* subsp. *discolor* var. *discolor*; M = *B. discolor* subsp. *discolor* var. *mossambicensis*; T = *B. discolor* subsp. *transvaalensis*; and U = *B. uniflora*.

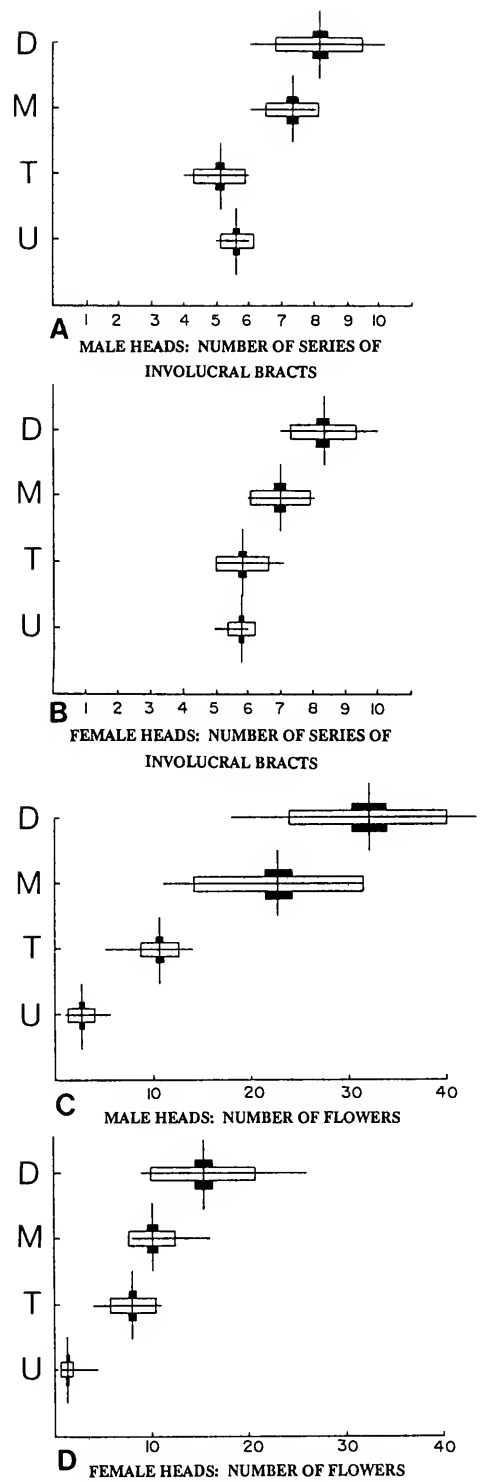


FIGURE 3.—Dice diagrams of all studied material of the *B. discolor-uniflora* complex. Variation in number of series of involucral bracts: A, male, and B, female heads; variation in number of flowers of C, male and D, female heads. D = *B. discolor* subsp. *discolor* var. *discolor*; M = *B. discolor* subsp. *discolor* var. *mossambicensis*; T = *B. discolor* subsp. *transvaalensis*; and U = *B. uniflora*.

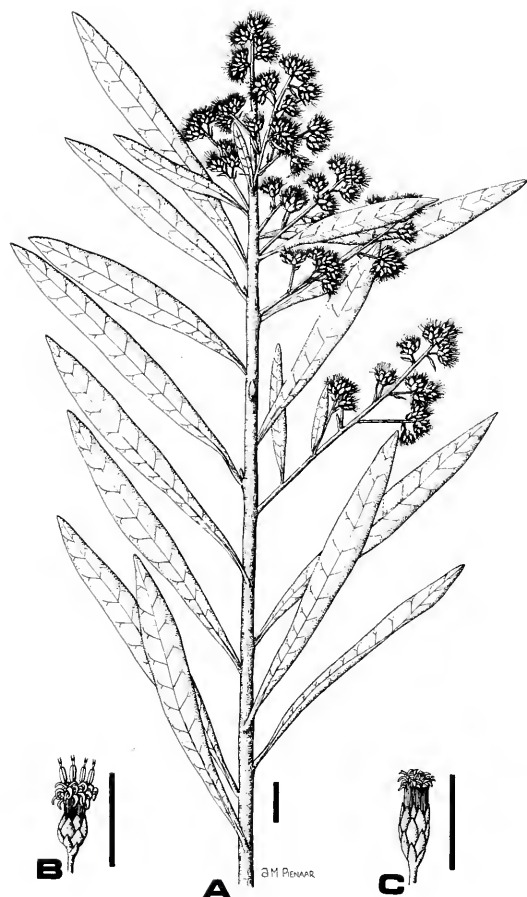


FIGURE 4.—*Brachylaena neriifolia* (L.) R. Br. A, branch with leaves and female heads, Cilliers 69; B, male head, Cilliers 73; C, female head, Cilliers 65. Scale bars: 10 mm.

male and 7–11 in female heads. *Pappus* 3–5 mm long. *Ovary* in male flowers 0.7–1.1 mm long, pubescent, rarely absent, sometimes fertile. *Staminodes* in female flowers, 0.6–1.0 mm. *Achene* oblanceolate to narrowly elliptic, 1–2 × 0.5–1.0 mm, pubescent glandular. *Flowering time*: December to February. Figure 4.

Leaves from coppice growth of *B. neriifolia* may sometimes be confused with leaves of *B. glabra*. The species, however, can usually be distinguished by the features given in the species key.

Distribution and habitat: *B. neriifolia* occurs in the southern Cape, extending from Giftberg and Piketberg in the north to the Storms River in the east (Figure 5). It is common along streambanks on mountains and in forests.

Vouchers: Barker 2955 (NBG); Cilliers 72 (PUC); Orchard 543 (STE); Paterson 1267 (GRA); Jacot Guillarmod 8700 (GRA).

2. *Brachylaena glabra* (L.f.) Druce in Report of the Botanical Society and Exchange Club of the British Isles 1916: 611 (1917); Phill. & Schweick.: 209 (1937); Hilliard: 106 (1977). Type: Cape, Thunberg s.n. (UPS, holo.–PRE (microfiche 18914!)).

Tarchonanthus glaber L.f.: 360 (1781); Thunb.: 638 (1823).

T. dentatus Thunb.: 145 (1800); Willd.: 1793 (1804); Pers.: 405 (1807); Thunb.: 638 (1823); Less.: 208 (1832). *B. dentata* (Thunb.) Harv.: 116 (1865); Sim: 246 (1907); Juel: 381 (1918); Sim: 44 (1921); Bews: 215 (1921); Henkel: 72 (1934); non DC. (1836). Type: Cape, Thunberg s.n. (UPS, holo.–PRE (18915), photo!).

B. grandifolia DC.: 430 (1836); Drège: 136 (1843). Type: Zuurbergen, Drège 2122 (G-DC, holo.!; K!).

Single-stemmed trees to multistemmed shrubs (2–) 5–20 m high; bark light grey to brown, not fissured; young branches with rusty brown down, glabrescent. *Leaves* petiolate, narrowly obovate to oblanceolate, sometimes narrowly elliptic, (30–)90–130(–225) × (12–) 20–60(–90) mm, coriaceous, glabrous adaxially, glabrous or rusty brown-tomentose abaxially, margins entire or serrated in upper half and on coppice shoots, base acute; petiole (8–) 10–15(–27) mm long. *Heads* many, in open axillary racemes or terminal panicles or racemes; peduncles of male heads (2.5–)4.0–6.0 mm, and of female heads 1–3 mm long. *Involucral bracts* in 4–7 series, 2.3–5.0(–7.0) × 0.6–4.0(–6.0) mm; individual bracts very narrowly to very broadly ovate, rusty brown. *Flowers* 13–24 in male heads, 3–10(–22) in female heads. *Pappus* 3–6 mm long. *Ovary* in male flowers 1.3–1.9 mm long, oblong, rarely absent, sometimes fertile. *Staminodes* in female flowers 0.8–2.0 mm long. *Achene* narrowly obovate to oblanceolate, 1.3–3.8 × 0.7–1.4 mm, pubescent glandular. *Flowering time*: March and April. Figure 6.

Distribution and habitat: *B. glabra* occurs mainly along the eastern Cape coast (Figure 5), in open spaces of high forest. At its northern limit in Natal (southeastern parts) (Figure 5) it forms a small tree or a shrub, mainly on south-facing sandstone outcrops and escarpment edges near the coast.

Vouchers: Abbott 1192 (NH); Cilliers 63, 133 (PUC); Fourcade 537 (BOL, GRA, PRE), 4499 (BOL); Ward 197 (NU); West 267 (BOL, GRA, PEU).

3. *Brachylaena ilicifolia* (Lam.) Phill. & Schweick. in Bothalia 3: 212 (1937); Hilliard: 108 (1977). Type: Cape, Sonnerat s.n. (K, iso!).

Baccharis ilicifolia Lam.: 345 (1783); Pers.: 423 (1807); Steud.: 177 (1841).

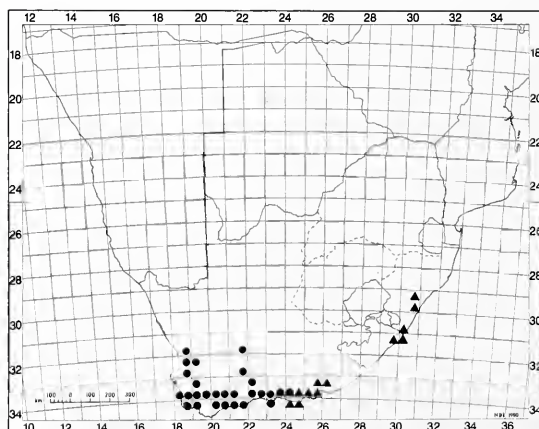


FIGURE 5.—Known geographic distribution of *Brachylaena neriifolia*, ●, and *B. glabra*, ▲.



FIGURE 6.—*Brachylaena glabra* (L.f.) Druce. A, branch with leaves and female heads, Thode A860; B, male head, Cilliers 133; C, female head, Cilliers 63. Scale bars: 10 mm.

Tarchonanthus racemosus Thunb.: 145 (1800); Thunb.: 638 (1823); Less.: 208 (1832). *Brachylaena racemosa* (Thunb.) DC.: 430 (1836); Harv.: 116 (1865); Sim: 246 (1907); Wood: 170 (1908); Juel: 381 (1918); Sim: 44 (1921); Bews: 215 (1921). Type: Cape, Thunberg s.n. (UPS, holo.-PRE (microfiche 18919)).

B. elliptica auct., non (Thunb.) DC.: 430 (1836) quoad descr. et spec.

Multistemmed shrubs or small trees (1–)3–4(–6) m high; bark dark grey to brown, fissured; young branches with white down, glabrescent. *Leaves* short-petiolate to subsessile, oblong to narrowly oblong, sometimes narrowly elliptic to elliptic or lanceolate to narrowly ovate, (10–)25–45(–75) × (4–)10–15(–30) mm, chartaceous, glabrous adaxially, white-tomentose and glandular abaxially, apex acute or obtuse to rounded, usually mucronate, margin entire or dentate, base acute to obtuse, sometimes rounded; petiole (0.5–)1.0–3.0(–5.0) mm long. *Heads* few, in dense axillary racemes, sometimes solitary; peduncles of male heads 0.5–1.0(–2.0) mm and of female heads 0.8–1.5(–2.0) mm long. *Involucral bracts* in 5–8 series, 2.5–5.0(–9.0) × 1.5–3.0(–4.0) mm; individual bracts narrowly to very widely ovate, sometimes narrowly to widely elliptic, glabrous to white tomentulose. *Flowers* 9–11 (–18) in male and 8–12 in female heads. *Pappus* 2–5 mm long. *Ovary* in male flowers, if present, up to 0.6 mm long. *Staminodes* in female flowers, if present, up to 0.2 mm long. *Achene* oblanceolate or narrowly elliptic, 2.1–3.6 ×

0.5–1.3 mm, pubescent glandular. *Flowering time*: August and September. Figure 7.

Distribution and habitat: *B. ilicifolia* occurs in scrub in the drier parts of northeastern Transvaal, northern and central Natal, and in the eastern Cape (Figure 8). It grows in dry river valleys and on dry hillslopes.

Vouchers: Bayliss 5052 (GRA); Cilliers 53, 147 (PUC); Dahlstrand 1995 (GRA, PRE); Feely 62 (NH, PRE, UN); Van Wyk 5246 (PRE, PRU).

4. *Brachylaena huillensis* O. Hoffm. in Botanische Jahrbücher 32: 149 (1902); Phill. & Schweick.: 212 (1937); Wild: 124 (1969); Paiva: 369 (1972); Hilliard: 107 (1977). Type: Angola, Huilla, Antunes 121 (K, iso!).



FIGURE 7.—*Brachylaena ilicifolia* (Lam.) Phill. & Schweick. A, branch with leaves and male heads, Bayliss 5052; B, male head, Bayliss 5052; C, female head, Cilliers 53. Scale bars: 10 mm.

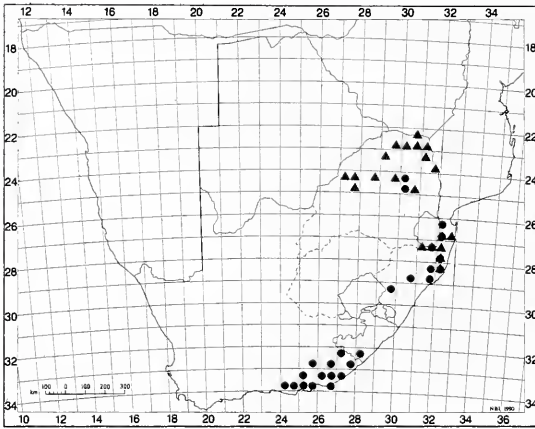


FIGURE 8.—Known geographic distribution of *Brachylaena ilicifolia*, ●; and *B. huillensis*, ▲, within southern Africa.

Tarchonanthus camphoratus auct. non L.: Hiern: 554 (1898); Gossw. & Mendonça: 121–123 (1939), *Welwitsch 6745* (could not be found).

B. hutchinsii Hutch.: 126 (1910); Brenan & Greenway: 149 (1949); Eggeling: 95 (1951); Dale & Greenway: 155 (1961); Cufod.: 1091 (1966). Type: Nairobi, *Hutchins s.n.* (K, holo.); Kenya, Nairobi, *Battiscombe 27 & 54* (K, para.).

Single-stemmed medium to large trees (5–)6–10(–15) m high; bark light grey to brown, deeply fissured; young branches with white down. *Leaves* petiolate, narrowly obovate to oblanceolate, sometimes narrowly elliptic to elliptic, (26–)45–75(–125) × (8–)16–30(–50) mm, coriaceous, glabrous adaxially, glandular and white-tomentose abaxially, apex acute, usually mucronate, margin entire, sometimes sinuate in front part or irregularly dentate, base acute, sometimes decurrent; petiole (3–)5–8 (–12) mm long. *Heads* few, in dense axillary racemes; peduncles of male heads 0.5–1.0(–2.0) mm and of female heads 0.5–1.0 mm long. *Involucral bracts* in 3–5 series, 2–4(–6) × 1.5–3.0(–5.0) mm, individual bracts ovate to very widely ovate, sometimes narrowly to widely elliptic, white-tomentose. *Flowers* 6–9(–10) in male and 5 in female heads. *Pappus* (1.5–)3.0–4.0(–6.0) mm long. *Ovary* in male flowers, if present, up to 0.3 mm long. *Staminodes* in female flowers, if present, up to 0.4 mm long. *Achene* oblanceolate or narrowly elliptic, 3.5–3.7(–4.0) × 1.0–1.3 mm, pubescent glandular. *Flowering time*: July. Figure 9.

Distribution and habitat: within southern Africa *B. huillensis* occurs in the northern parts of Transvaal, in Zululand and Natal (Figure 8). It is confined to short forest, woodland and bush, usually on sandy soils.

Vouchers: *Cilliers 79, 100, 104* (PUC); *Lang s.n.* (BOL, NBG); *Moll & Strey 3755* (NH); *Pooley 883* (UN); *Ward 7119* (NH).

5. *Brachylaena elliptica* (Thunb.) DC. in *Prodromus systematis naturalis regni vegetabilis* 5: 430 (1836), quoad basionym excl. spec. et descr.; Harv.: 116 (1865); Sim: 92 (1907); Wood: 169 (1908); Juel: 381 (1918); Sim: 44 (1921); Bews: 215 (1921); Henkel: 72 (1934); Phill. & Schweick.: 216 (1937). Type: Cape, *Thunberg s.n.* (UPS, holo.–PRE (microfiche 18916)).

Tarchonanthus ellipticus Thunb.: 145 (1800); Willd.: 1793 (1804); Pers.: 405 (1807); Thunb.: 638 (1823); Spreng.: 456 (1826) excl. syn.; Less.: 208 (1832).

B. dentata DC.: 430 (1836), non (Thunb.) Harv.; Type: Zuurborgen, *Drège 3659* (G-DC, lecto., here designated); Albany, *Burchell 3400* (G-DC!); Kaffraria, *Ecklon 791, 793* (G-DC!).

Multistemmed shrubs or small trees (2–)4–6(–8) m high; bark dark grey to brown, fissured; young branches with white down, glabrescent. *Leaves* petiolate, widely to narrowly obovate or narrowly oblanceolate, sometimes narrowly elliptic to oblong, (21–)40–70(–76) × (6–)15–30 (–62) mm, chartaceous, glabrous adaxially, glandular and white-tomentose abaxially, apex acute or obtuse, sometimes mucronate, usually 3-lobed, margins entire or dentate, base acute, rarely obtuse; petiole (1–)3–4(–6) mm long. *Heads* many, in open axillary or terminal racemes



FIGURE 9.—*Brachylaena huillensis* O. Hoffm. A, branch with leaves and male heads, *Cilliers 104*; B, male head, *Cilliers 104*; C, female head, *Ward 7119*. Scale bars: 10 mm.



FIGURE 10.—*Brachylaena elliptica* (Thunb.) DC. A, branch with leaves and male heads, Bayliss 8747; B, male head, Bayliss 8747; C, female head, Cilliers 38. Scale bars: 10 mm.

or panicles; peduncles of male heads 0.5–1.0 mm and of female heads 0.5–1.5 mm long. *Involucral bracts* in 3–6 series, 1.5–3.0(–5.0) × 0.5–1.5(–2.0) mm; individual bracts narrowly to very widely ovate, sometimes lanceolate, white tomentulose. *Flowers* (4–)7–11(–15) in male and 4–10 in female heads. *Pappus* 1.5–2.5(–4.0) mm long. *Ovaries* in male flowers, if present, up to 0.4 mm long. *Staminodes* in female flowers, if present, up to 0.8 mm long. *Achene* narrowly obovate to narrowly oblanceolate, 2.1–3.2 × 0.5–1.0 mm, pubescent glandular. *Flowering time*: April, May and June. Figure 10.

The leaves of *B. elliptica* are very variable in their shape and often conspicuously 3-lobed or 3-toothed at the apex; they sometimes resemble those of *B. glabra*, but are shorter, not as wide and white-tomentose (never glabrous) abaxially.

Distribution and habitat: *B. elliptica* is widespread in the eastern Cape from Uitenhage eastwards through Transkei to Natal and Zululand (Figure 11). It can be found in coastal and river bush, valley bushveld, in scrub or on grassy slopes, often on rocky ridges.

Vouchers: Cilliers 27, 38, 50 (PUC); MacOwan 244 (NH); Olivier 2141 (PEU); Osborne 232 (GRA); Strey 6699 (NH, PRE).

6. *Brachylaena rotundata* S. Moore in Journal of Botany: 131 (1903); Burt Davy & Pott-Leend.: 168 (1912); Eyles: 508 (1916); Sim: 44 (1921); Phill. & Schweick.: 218 (1937); Wild: 123 (1969); Paiva: 372–375 (1972). Type: Transvaal, north escarpment of Witwatersrand series, Rand 738 (BM, holo.).

B. rhodesiana S. Moore 37: 448 (1906); S. Moore: 108 (1911); Eyles: 508 (1916). Type: Rhodesia, Matopo hills, Gibbs 72 (BM, holo.; K, iso.).

B. discolor auct. non DC.: Munro: 90 (1908); Eyles: 508 (1916).

Single-stemmed large shrubs or medium-large trees (3–)5–8(–15) m high; bark dark brown to black, deeply fissured; young branches white-tomentose, glabrescent. *Leaves* petiolate, narrowly to widely elliptic, sometimes narrowly obovate or oblong, (25–)50–100(–160) × (15–)30–50(–90) mm, coriaceous, glabrous to white-tomentose adaxially, white-tomentose abaxially, glandular, apex acute to obtuse, sometimes rounded, margins entire or crenate smoothly rounded, sometimes dentate in coppice shoots, base obtuse to rounded; petiole (1–)3–7(–10) mm long. *Heads* many, in open axillary or terminal racemes or panicles, peduncles of male heads 1.0–1.5(–2.0) mm and of female heads 0.5–3.0 mm long. *Involucral bracts* in 4–10 series, 3–6(–8) × 2–3(–5) mm; individual bracts ovate to very widely ovate, sometimes lanceolate, white-tomentulose. *Flowers* 13–28(–31) in male and 11–27 in female heads. *Pappus* 3.0–6.5 mm long. *Ovaries* absent in male flowers. *Staminodes* absent in female flowers. *Achene* narrowly elliptic, 1.6–3.8 × 0.5–1.0 mm, pubescent glandular. *Flowering time*: August and September. Figure 12.

Distribution and habitat: within southern Africa *B. rotundata* occurs in the northeastern, southern and western parts of Transvaal and occasionally on the Free State side of the Vaal River (Figure 11). It is common on rocky ridges and hills and the edges of dry kloof bush.

Vouchers: Adlam & Wood 5633 (NH); Botha & Ubbink 1556 (PUC, PRE); Cilliers 149, 151 (PUC); Leendertz 235 (GRA, KMG, NH); Theron 1557 (PRE, PRU).

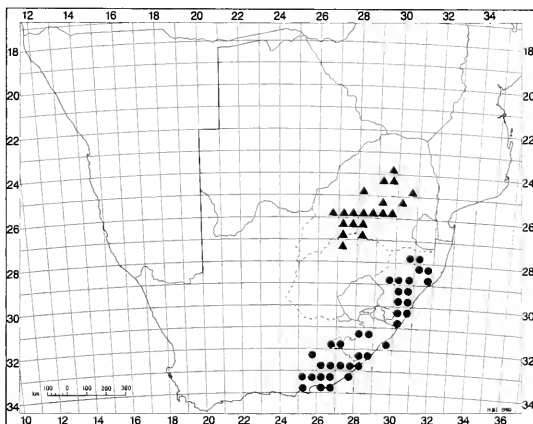


FIGURE 11.—Known geographic distribution of *Brachylaena elliptica*, ●; and *B. rotundata*, ▲, within southern Africa.

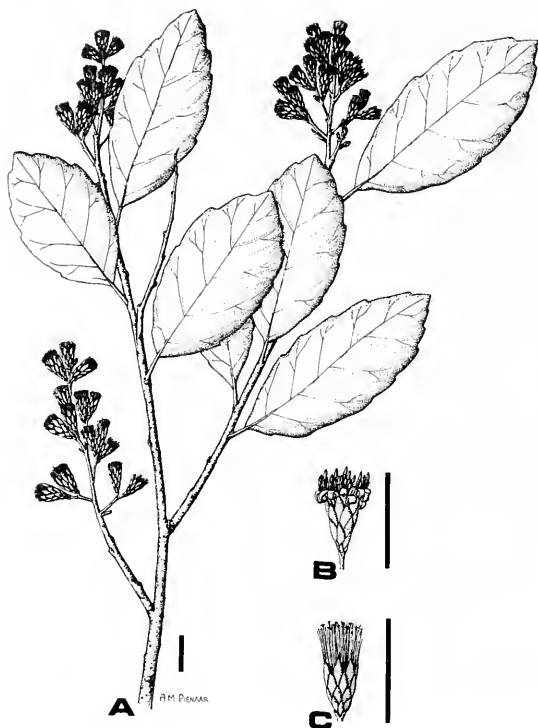


FIGURE 12.—*Brachylaena rotundata* S. Moore. A, branch with leaves and female heads, *Cilliers* 149; B, male head, *Cilliers* 151; C, female head, *Cilliers* 150. Scale bars: 10 mm.

7. *Brachylaena discolor* DC. *Prodromus systematis naturalis regni vegetabilis* 5: 430 (1836); Drège: 155, 157 (1843); Harv.: 117 (1865); Wood & Evans: 23, 24 (1898); Sim: 247 (1907); Wood: 169 (1908); Sim: 44 (1921); Bews: 215 (1921); Henkel: 72 (1934); Phill. & Schweick.: 219 (1937); Macnae & Kalk: 154 (1958); Wild: 123 (1969); Hilliard & Burt: 3 (1971); Paiva: 369 (1972); Hilliard: 109 (1977). Type: Cape, Uitenhage District, *Burchell* 3751 (G-DC, lecto!., here designated); Uitenhage, *Ecklon* 1422 (G-DC!); between the Umzimkulu and Um-tentu Rivers, Drège 5043 (G-DC!); Mozambique, Delagoa Bay, *Forbes* s.n. (G-DC!).

Multistemmed shrubs or small to large trees (2–)6–10 (–20) m high; bark light grey to brown, fissured; young branches with white down, glabrescent. *Leaves* petiolate, oblanceolate to narrowly obovate, sometimes elliptic to narrowly elliptic; (50–)70–100(–190) × (15–) 25–45(–60) mm, glabrous adaxially, white-tomentose abaxially, glandular, apex acute, sometimes obtuse, rarely rounded, margin entire, sinuated or serrated over whole margin or in upper half and in coppice shoots, base decurrent into a petiole; petiole (3–)8–10(–12) mm long. *Heads* many, in open axillary or terminal racemes or panicles, peduncles of male heads 0.5–3.0(–5.0) mm and of female heads 0.4–4.0 mm long. *Involucral bracts* in 4–10 series, (1.5–)3.0–10.0(–15.0) × (0.5–)2.0–4.0 (–6.0) mm; individual bracts narrowly to very widely ovate, sometimes elliptic to narrowly elliptic, white-tomentulose to tomentose. *Flowers* 1–45 in male and 1–26 in female heads. *Pappus* 2.0–8.5 mm long. *Ovary* in male flowers, if present, up to 0.5

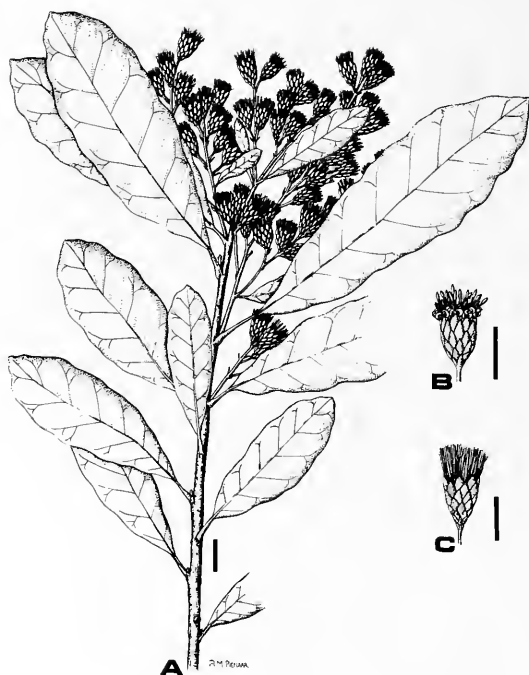


FIGURE 13.—*Brachylaena discolor* DC. subsp. *discolor*. A, branch with leaves and female heads, *Harrison* 29; B, male head, *Cilliers* 135; C, female head, *Cilliers* 109. Scale bars: 10 mm.

mm long. *Staminodes* in female flowers, if present, up to 0.7 mm long. *Achene* narrowly obovate to linear, 1.0–3.9 × 0.4–1.0 mm, pubescent glandular. *Flowering time*: July, August and September.

B. discolor can usually be distinguished from the other species by the leaf base which is mostly decurrent into the petiole.

Distribution and habitat: *B. discolor*, one of the most widely distributed species in the genus, occurs in northern and eastern Transvaal, through Swaziland and the eastern

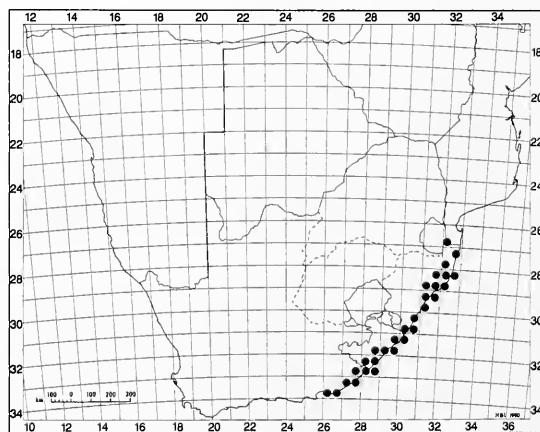


FIGURE 14.—Known geographic distribution of *Brachylaena discolor* subsp. *discolor* within southern Africa.

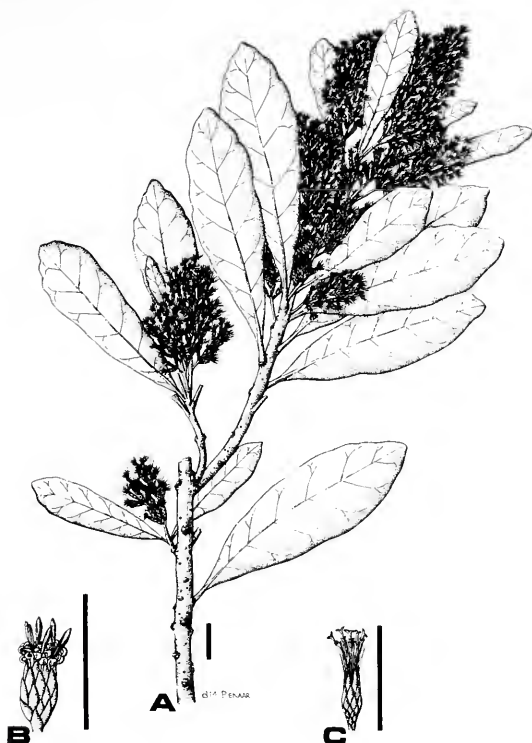


FIGURE 15.—*Brachylaena discolor* DC. subsp. *transvaalensis* (Phill. & Schweick.) J. Paiva. A, branch with leaves and female heads, Cilliers 134; B, male head, Cilliers 137; C, female head, Cilliers 144. Scale bars: 10 mm.

parts of Natal and Transkei up to the mouth of the Bushmans River in the eastern Cape. Its habitat varies from inland forests on valley slopes and plateaux to coastal forests, scrub and dune bush.

Key to subspecies

In 10–15% of the specimens investigated, the values of the characters used in this key overlapped.

1a Involucral bracts of male heads in 7–10 (rarely 6) series; peduncle of male heads up to 5 mm long; involucral bracts of female heads in 6–10 series; peduncle of female heads 1–4 mm long; involucral bracts up to 12 mm long in male heads and up to 15 mm long in female heads 7a. subsp. *discolor*

1b Involucral bracts of male heads in 4–6 series; peduncle of male heads up to 1 mm long; involucral bracts of female heads in 5–7 series; peduncle of female heads 0.4–1.5 mm long; involucral bracts up to 4 mm long in male heads and up to 6 mm long in female heads 7b. subsp. *transvaalensis*

7a. subsp. *discolor*

J. Paiva in Boletim da Sociedade Broteriana 46: 369 (1972).

B. natalensis Sch. Bip.: 972 (1843); Sch. Bip.: 671 (1844); Harv.: 117 (1865). Type: prope Natal-Bay [Durban], Krauss 243 (G, holo.).

B. discolor subsp. *discolor* var. *mossambicensis* J. Paiva 46: 369 (1972). Type: Nhamoongo, 90 km south of Inhambane, Gomes & Sousa 1667 (COI, holo.).

B. rhodesiana auct. non S. Moore: S. Moore: 108 (1911) quoad specim. Swynnerton 6515.

Multistemmed shrubs or small trees, usually not higher than 6–8 m. *Male heads* with involucral bracts in 7–10 series, involucre 3–10(–12) mm long; peduncles 1–5 mm long; 11–39 flowers per head. *Female heads* with involucral bracts in 6–10 series, involucre 6.0–13.5(–15.0) mm long; peduncles 1–4 mm long; 9–26 flowers per head. Figure 13.

Distribution and habitat: *B. discolor* subsp. *discolor* is a common coastal species (with an occasional inland occurrence, e.g. Hluhluwe Game Reserve) found from the mouth of the Bushmans River in the eastern Cape to Transkei, Natal and Zululand (Figure 14).

Vouchers: Cilliers 108, 109, 135 (PUC); Flanagan 861 (NBG); Muirhead K17 (RUH); Schweickerdt 1384 (NH. STE); Strey 8751, 8753, 8783, 8793, 8795, 8798 (NH).

7b. subsp. *transvaalensis* (Phill. & Schweick.) J. Paiva in Boletim da Sociedade Broteriana 46: 369 (1972).

B. transvaalensis Phill. & Schweick.: 214 (1937); Hilliard & Burt: 3 (1971). Type: South Africa, Transvaal, Pietersburg, between Houtbos and Haenertsburg, Hutchins s.n. (K, holo.).

B. uniflora Harv.: 117 (1865); Bews: 215 (1921); Phill. & Schweick.: 211 (1937); Hilliard & Burt: 3 (1971); Hilliard: 109 (1977). Type: Natal, on mountains, 30–60 miles from the sea, Sutherland s.n. (K, holo.).

Single-stemmed medium-large to large trees, not higher than 20 m. *Male heads* with involucral bracts in 4–6 series, involucre 1–4 mm long; peduncles 0.5–1.2 mm long; 1–14 flowers per head. *Female heads* with involucral bracts in 5–7 series, involucre 3–6 mm long; peduncles 0.4–1.5 mm long; 1–11 flowers per head. Figure 15.

Distribution and habitat: within southern Africa *B. discolor* subsp. *transvaalensis* occurs in the northern and eastern Transvaal and in Swaziland, as well as in the northeastern and southern parts of Natal and the Transkei (Figure 16). It can be found in inland and coastal forests, but not in dune bush or forests directly facing the sea.

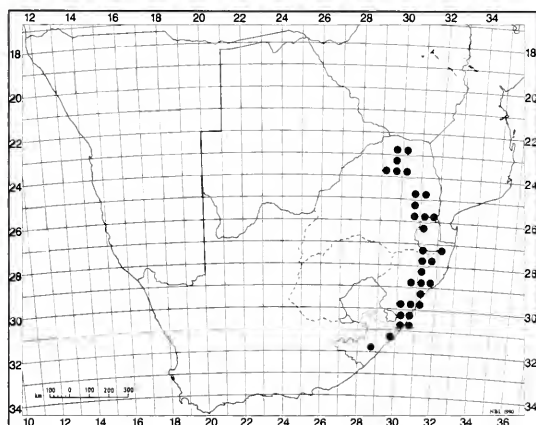


FIGURE 16.—Known geographic distribution of *Brachylaena discolor* subsp. *transvaalensis*.

Vouchers: Cilliers 120, 137, 144 (PUC); Compton 29073 (NBG); Keet 1130 (STE); Schrire, Van Wyk & Abbott 1782 (NH); Strey 8752, 8819, 8820 (NH).

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Nomenclatural changes and additions to the genus *Ophioglossum* in Africa (Ophioglossaceae: Pteridophyta)

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Keywords: Africa, new combination, new species, *Ophioglossum*, Pteridophyta, taxonomy

ABSTRACT

Recent research has necessitated a review of the nomenclature of the genus *Ophioglossum* in Africa. This paper establishes a new species, *O. caroticaule* J.E. Burrows, a new subspecies, *O. vulgatum* L. subsp. ***africanum*** Pocock ex J.E. Burrows, and a change in status, *O. latifolium* (Prantl) J.E. Burrows (basionym: *O. gomeziianum* var. *latifolium* Prantl). Lectotypification is provided for *O. gracillimum* Welw. ex Hook. & Bak., *O. lusoafricanum* Welw. ex Prantl, *O. latifolium* (Prantl) J.E. Burrows, and *O. rubellum* Welw. ex A. Braun. Nomenclatural problems in *O. lancifolium* Presl are discussed.

UITTREKSEL

Onlangse navorsing het 'n hersiening van die nomenklatuur van die genus *Ophioglossum* in Afrika noodsaaklik gemaak. 'n Nuwe spesie, *O. caroticaule* J.E. Burrows, 'n nuwe subspesie, *O. vulgatum*, L. subsp. ***africanum*** Pocock ex J.E. Burrows, en 'n verandering in status, *O. latifolium* (Prantl) J.E. Burrows (basioniem: *O. gomeziianum* var. *latifolium* Prantl), word in hierdie artikel beskryf. Lektotipifikasie word verskaf vir *O. gracillimum* Welw. ex Hook. & Bak., *O. lusoafricanum* Welw. ex Prantl, *O. latifolium* (Prantl) J.E. Burrows, en *O. rubellum* Welw. ex A. Braun. Nomenklatoriese probleme in *O. lancifolium* word bespreek.

INTRODUCTION

The genus *Ophioglossum* L. has received no taxonomic attention in Africa since Clausen's (1938) confusing monograph of the genus. The simple morphological structure of the plants together with apparently considerable intraspecific variation has caused compilers of African regional floras to either follow Clausen's nomenclature or assume a conservative stance by maintaining broadly circumscribed species which, in the light of recent studies, are often composed of two or more clearly distinct taxa.

The most important development since Clausen's work is the publication by Wagner & Wagner (1983) of their 'genus communities' concept, based upon work on the genus *Botrychium* Swartz (Ophioglossaceae) in North America. This concept made use of the fact that *Botrychium* (like *Ophioglossum*) frequently grows together in multiple species communities and, when this occurs, one is able to make rational comparisons between taxa occurring within a community, particularly if these differences are maintained in communities found elsewhere under different edaphic and climatic conditions. This concept has provided taxonomists with a valuable additional tool with which to distinguish between environmentally-induced variation and differences that are genetically controlled.

During recent studies, the senior author has discovered an unique area in northwestern Zimbabwe which supports 11 species of *Ophioglossum*. Additional genus communi-

ties have since been located in both Zimbabwe and South Africa which have made a better delimitation and definition of the southern African species of *Ophioglossum* possible. However, these studies have resulted in the need to revise the nomenclature of several of the taxa occurring on the African subcontinent.

DISCUSSION

In 1983, the senior author collected nine species of *Ophioglossum* growing within an area of about six square kilometres in the Sengwa Wildlife Research Area of north-western Zimbabwe. Subsequent collecting at Sengwa has yielded a further two species, bringing the total to eleven, a situation not recorded to date elsewhere in the world for the genus *Ophioglossum*. Additional genus communities have been discovered by the senior author on Ngoma-kurira, northeastern Zimbabwe (6 species), Elim Hospital, eastern Zimbabwe (4 species), Treur River, eastern Transvaal (5 species) and several communities composed of two or three species each. These localities occur on various substrates (sandstone, granite, quartzite and dolomite) and under varying climatic conditions, and the consistent differences displayed between members of these genus communities have allowed for clearer definitions to be established between taxa.

However, the specific concepts within the African members of *Ophioglossum* entrenched by Tardieu-Blot (1953, 1964) and Schelpe (1970, 1977) do not adequately cover the number of taxa that are evident from genus community studies. This was noted by Dr Mary Pocock of Grahamstown who spent much time studying the South African species of *Ophioglossum*. She recorded her concepts in a manuscript which unfortunately was never pub-

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lished. The author's studies corroborate some of Pocock's species concepts and one of her taxa is published below.

Spore morphology is a valuable taxonomic tool within the southern African species of *Ophioglossum* even though it cannot be readily employed for rapid determinations in herbaria.

1. The *Ophioglossum lancifolium* aggregate

Key to species

- 1a Trophophore linear with a length:width ratio >10:1; trophophore frequently falcate *O. gracillimum*
- 1b Trophophore narrowly lanceolate to narrowly elliptic with a length:width ratio <10:1; trophophore not falcate:
 - 2a Old rhizomes strongly linear, with a length:width ratio >6:1; spore wall lumina distinct, muri clearly reticulate *O. lusoafricanum*
 - 2b Old rhizomes short or ellipsoid, with a length:width ratio <6:1; spore wall lumina reduced to conical pits:
 - 3a Trophophore linear-elliptic, length:width ratio >6:1; rhizome ellipsoid *O. caroticaule*
 - 3b Trophophore elliptic, length:width ratio <6:1; rhizome linear sp. aff. *O. lancifolium*

1.1. *Ophioglossum caroticaule* J.E. Burrows, sp. nov., ab *O. gracillimo* sporis aletis et trophophoris majoribus et latioribus differt; etiam *O. lusoafricanum* similis sed rhizomate brevi et latiore, trophophoro apiculato et sporis lumina parva et conica ostendentibus differt.

TYPUS.—Zimbabwe: Gokwe Dist., Sengwa Wildlife Research Area, Leguaan Vlei, 880 m, 11-2-1991, J.E. & S.M. Burrows 5153 (K, holo.; PRE, SRGH, iso.). Figures 1; 2A, B.

Rhizome 4–14 × 2.0–3.5 mm (ratio 2.6:1), ellipsoid, with wiry, semi-descending roots which are rarely proliferous. **Stipe** 18–40 mm long, ± 0.5 of its length subterranean, dead stipes sometimes slightly persistent. **Trophophore** usually solitary, erect, 14–39 × 2.5–5.0 mm (ratio 7.2:1), very narrowly elliptic, sterile trophophore flat, fertile trophophore shallowly folded, apex sharply apiculate, venation linear, epidermal cell walls sinuous, stomata anomocytic. **Sporophore** 40–60 mm long, bearing (6–)12–15(–19) pairs of sporangia. **Spores** alete, 43–49 µm in equatorial diameter, muri thick, ± 3 µm wide, continuous and somewhat undulate, lumina conical, 1.5–2.3 µm wide, proximal surface concave, pitted (Figure 2A, B).

This taxon was included under *O. lancifolium* s.l. which comprises three or more species in Africa. It closely resembles *O. lusoafricanum* but is clearly differentiated from it by the spores with their conical lumina, and the short, ellipsoid rhizome. The apex of the trophophore is generally sharply apiculate compared to the acute apex of *O. lusoafricanum*. *O. gracillimum* is separated from *O. caroticaule* by its trilete and smaller spores, 27–38 µm in equatorial diameter (Figure 2D, E), and its much narrower and slightly falcate trophophore.

Ophioglossum caroticaule appears, from the few known collections, to be a species of shallow, sandy or humic loams which are seasonally moist or wet, growing among sparse, short grasses in subtropical deciduous

woodland or on open sheetrock on seasonally wet vegetation islands. It is a gregarious species and, in all populations so far seen in the field, grows with either *O. lusoafricanum*, *O. gomezianum* Welw. ex A. Br., *O. rubellum* Welw. ex A. Br. or *O. costatum* R. Br.

Specimens examined

(Localities identified in terms of grid reference system—see Edwards & Leistner 1971.)

ETHIOPIA.—0539: Sidamo, Bitata, 20 km from Negele on road to Menghist, 1 450 m, 24-5-1983, Gilbert, Ensermu & Vollesen 7762 (K).

KENYA.—0237: K4 Machakos, Nairobi-Mombasa Road, 7.4 km towards Nairobi from Hunter's Lodge, 960 m, 6-1-1972, Faden & Faden 72/18 (K, MO).

ZAMBIA.—0831: Abercorn Dist., old road to Cascalawa, 16-2-1960, Richards 12480 (K).

ZIMBABWE.—1828 (Gokwe): Gokwe Dist., Sengwa Wildlife Research Area, Leguaan Vlei, 13-2-1983, Burrows 3016 (J.E.B. Herb.); 11-2-1991, Burrows & Burrows 5153 (K, holo., PRE, SRGH), 2027 (Plumtree): Matopo Hills, Bulalima-Mangwe, Embakwe, (–DD), 10-5-1942, Feiertag s.n. (BM, SRGH), 2028 (Bulawayo): Matopo Hills, Bulalima-Mangwe, Greystone, (–CA), 1-5-1939, Feiertag s.n. (BM, SRGH).

SOUTH AFRICA

TRANSVAAL.—2429 (Zebediela): Potgietersrus, Percy Fyfe Nature Reserve, (–AA), 1 500 m, 22-2-1971, Huntley 2013 (PRE), 2430 (Pilgrim's Rest): Bourke's Luck, Goedgeloof Plantations, Treur River, (–DB), 1 200 m, 27-12-1990, Burrows 5113 (J.E.B. Herb.).

1.2. *Ophioglossum gracillimum* Welw. ex Hook. & Bak., Synopsis filicum: 445 (1868); Burrows: 40 (1990); Johns: 8 (1991). Type: Angola, Pungo Andongo, near Catete, Jan. 1857, Welwitsch 36 (BM, lecto.!; K!, LISU, iso.).



FIGURE 1.—*Ophioglossum caroticaule*, Burrows 3016, Sengwa Research Area, Zimbabwe.

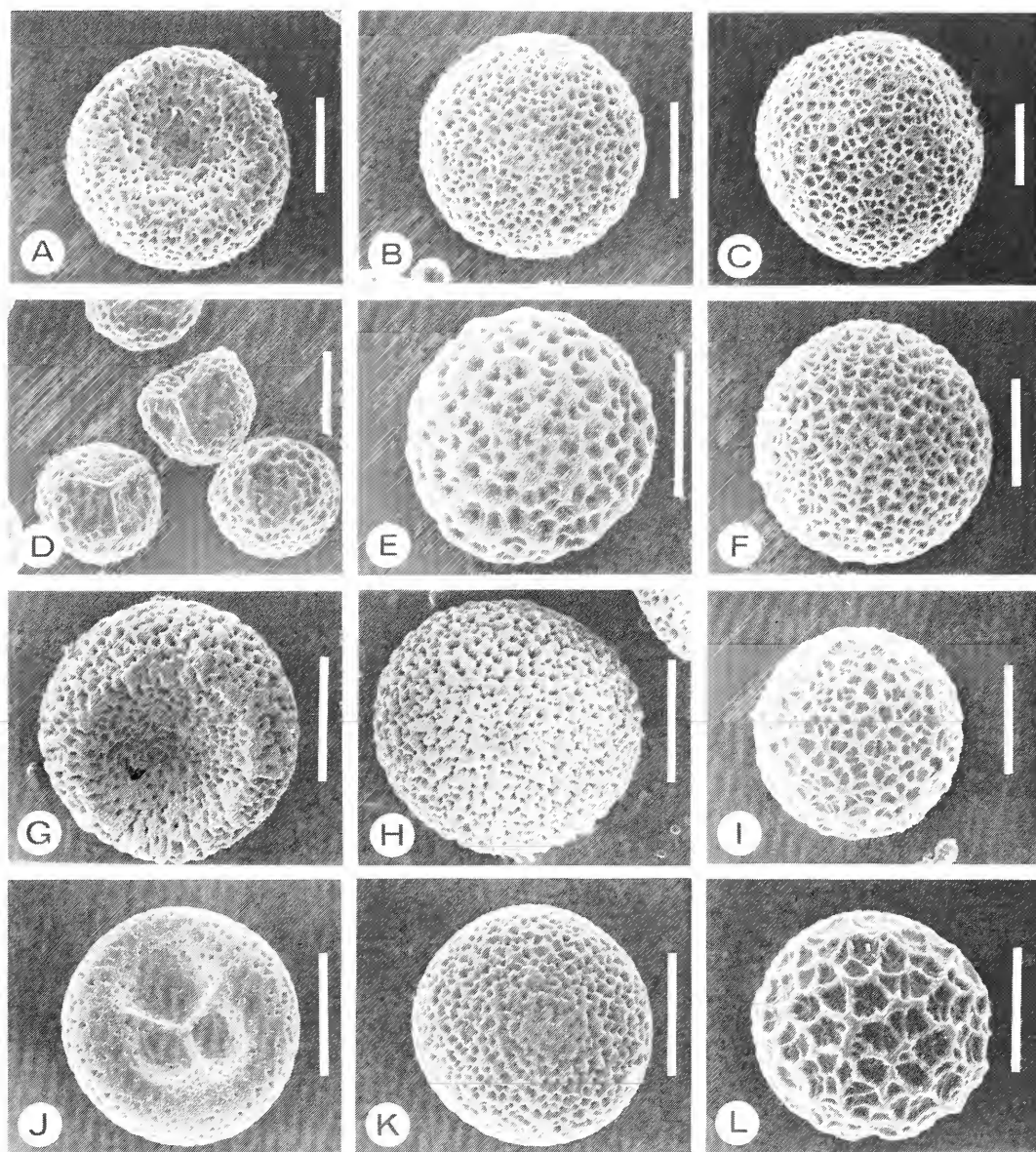


FIGURE 2.—Spores of *Ophioglossum*. *O. caroticaule*, J.E. & S.M. Burrows 5153: A, proximal, B, distal. *O. lusodfricanum*: C. J.E. & S.M. Burrows 5147, distal; F, Burrows 4949, distal. *O. gracillimum*, J.E. & S.M. Burrows 5138: D, proximal, E, distal. *O. sp. aff. lancifolium*, J.E. & S.M. Burrows 5158: G, proximal, H, distal. *O. vulgatum* subsp. *africanum*, J.E. & S.M. Burrows 5122: J, proximal, K, distal. *O. convexum*, J.E. & S.M. Burrows 5213: I, L, distal. Scale bars: 20 μ m.

O. lusitanicum L., var. *gracillimum* Welw. ex A. Br.: 177 (1868).
O. gramineum Willd., sensu Schelpe: 34 (1977).

Although the collection *Welwitsch 36* is repeatedly quoted as the type material of this species, no single element has been selected from what are, by Welwitsch's own admission (on the BM sheet), several different collections, albeit from the same area or locality. After his initial gathering in January 1857, to which he allocated the number 36, Welwitsch apparently re-collected this species on three occasions. Subsequent collections made in February were then numbered 36a, 36b and 36c and the BM sheet bears plants from all four gatherings. Since the January

collection (No. 36) is the first collection, and is typical of the species, the group of seven central plants immediately above the brown label on the sheet housed in BM, is hereby selected as the lectotypic element for the name of the species, with isotypic specimens in K and LISU.

The practice of placing Welwitsch's species under the superficially similar Australo-Asian species *O. gramineum* (Prantl 1883; Carruthers 1901; Clausen 1938; Tardieu-Blot 1953, 1964; Schelpe 1977) is, in my opinion, unfounded and *O. gracillimum* is hereby maintained as a clearly defined species confined to Africa.

Distribution: Ghana, Tanzania, Angola, Zimbabwe, South Africa (Transvaal).

1.3. *Ophioglossum lusoaffricanum* Welw. ex Prantl in *Berichte der Deutschen Botanischen Gesellschaft* 1: 351 (1883); Pichi Sermolli: 641 (1954); Faden: 25 (1974). Type: Angola, Pungo Andongo, *Welwitsch* 34 (B, holo. [destroyed]; BM!, neo.; K!, LISU, iso.).

Soon after the publication of Welwitsch's epithet, the taxon was sunk into *O. gramineum* Willd. by Clausen (1938) who then, in July 1939, annotated Welwitsch's sheet of *O. lusoaffricanum* in Kew as *O. lancifolium* Presl. In southern Africa, Schelpe (1970) and Schelpe & Anthony (1986) have retained the epithet *O. lancifolium* for all species of *Ophioglossum* with a narrowly elliptic to lanceolate trophophore which is held clear of the ground on a distinct stipe. Recent studies have shown that there are three distinct taxa that display these general characters within south-central Africa. *O. caroticaule* (described above) appears to be rare. The most common species is a taxon with a rather variable trophophore shape and size but with two characters which clearly differentiate it from what is believed to be typical *O. lancifolium*: spore sculpturing (Figure 1A & B) and rhizome shape. This common taxon matches perfectly Welwitsch's *O. lusoaffricanum*, a fact also recognized by Pichi Sermolli (1954) and Faden (1974). What is thought to be true *O. lancifolium* is recorded from central Africa but is not recorded from south of the 20°S line of latitude, being apparently confined to the Zambezan phytogeographical region (White 1983).

In his type description, Prantl (1884) quotes a specimen in Berlin as the type collection. Since all Berlin's *Ophioglossum* material was destroyed during World War 2, a neotype must be selected.

All the sheets seen of *Welwitsch* 34 in K and BM comprise more than one gathering. Although probably all of the same species, in a genus with species so poorly differentiated as *Ophioglossum*, it is essential that a single gathering is selected as the type to avoid taxonomic ambiguity. Therefore the top collection on the sheet in BM, composed of nine plants collected in January 1857, is hereby selected as the neotype of *O. lusoaffricanum*.

O. lusoaffricanum displays a confusing trait whereby the first emerging trophophore from a root sucker is frequently ovate to orbicular and appressed to the ground, thereby resembling *O. convexum* J. E. Burrows. These small, ovate forms may sometimes produce fertile spikes, giving the impression that there are two topotypic species. However the spore pattern of the two species is quite different (Figure 2C, F, I, L) with *O. convexum* being consistently trilete and *O. lusoaffricanum* being alete or trilete, or rarely monolete. The spore sculpturing of *O. convexum* is variable which may indicate hybrid activity in some forms.

1.4. *Ophioglossum lancifolium* Presl, *Supplementum tentaminis pteridographiae* (1845). Type: Mauritius, *Du Petit-Thouars* s.n. (PR, holo., P!, iso.?).

O. lancifolium is a name that has been widely applied to any species of *Ophioglossum* in tropical Africa that

bears a narrow trophophore well clear of the ground (Schelpe 1970; Tardieu-Blot 1953; Jacobsen 1983). Although plants which roughly correspond to Thouars' plants have been collected in central Africa, the status of *O. lancifolium* cannot be verified on the African mainland until good topotypic material is located from Mauritius. The extant specimens in Paris collected by Du Petit-Thouars from Mauritius are extremely poor and inadequate for a sound comparison. Specimens from mainland Africa share the same trophophore shape, the same rhizome form and (possibly) the same spore ornamentation (Figure 2G, H). However it is vital that live plants are seen and collected from Mauritius before the African taxon can be equated with the type of *O. lancifolium*. Unfortunately Lorence, in his survey of the pteridophytes of Mauritius (1978), records against *O. lancifolium*: 'not seen recently'.

The distribution of the African taxon currently attributable to *O. lancifolium*: Angola, Namibia, Botswana, Zambia, Zimbabwe.

2. *Ophioglossum latifolium* (Prantl) J.E. Burrows, stat. nov.

O. gomezianum Welw. ex A. Br. var. *latifolium* Prantl in *Jahrbuch des Königlichen Botanischen Gartens und des Botanischen Museums zu Berlin* 3: 307–333 (1884). Type: Angola, Pungo Andongo, near Catete, Feb. 1857, *Welwitsch* 32 (K, lecto.!, the right-hand specimen here designated; BM!, LISU, iso.).

O. latifolium most closely resembles *O. rubellum* Welw. ex A. Br. (with which it is most frequently confused) but differs in its much larger size, its more slender rhizome with wider-spreading proliferous roots, the lack of orange pigmentation in the pedicel and trophophore, and its completely different spore ornamentation.

Up to now we have thought that this taxon could be a hybrid since three spore samples examined have all had malformed or undeveloped spores. This fact is also noted by Prantl in his original description where he states 'spores degenerae'. However, apparently normal spores have been found in some collections which, together with this species' wide distribution, suggests that it is probably a stabilised hybrid with a very low percentage of viable spores produced. This is borne out by the populations seen being extremely localised and of obvious clonal origin. Nonetheless, there is no reason not to consider it a good species.

There seems to be no valid reason to assume that *O. latifolium* is allied to *O. gomezianum* since it shares very few characters with the latter species. Most noticeably, it lacks the suborbicular or ellipsoid rhizome that is typical of *O. gomezianum*, whereas its consistently broader trophophores which are held almost flat on the ground, clearly separate it from *O. gomezianum*, and the taxon is therefore elevated to species level.

Although no holotype was designated by Prantl in his description, Schelpe (1977) illegitimately quotes the Kew collection as the holotype. The Kew sheet comprises two collections and the right-hand collection on the Kew sheet is hereby selected as the lectotype of the name *O. latifol-*

ium. Ballard's determination of that collection as *O. costatum* is incorrect.

Distribution: Sierra Leone, Nigeria, Kenya, Zaïre, Angola, Zambia, Zimbabwe.

3. *Ophioglossum vulgatum* L. subsp. *africanum* Pocock ex J.E. Burrows, subsp. nov., ab *O. vulgato* subsp. *vulgato* sporis glabrioribus reticulo murorum tenuiore aequabiliore luminisque fovearum conicis \pm 1.0–1.5 μ m latis diminutis differt.

TYPUS.—2929 (Underberg): South Africa, Natal, Bergville Dist., Cathedral Peak Forest Research Station, Catchment 9, (–AB), 1 905 m, 9-1-1951, Killick 1267 (NU, holo.; PRE, iso.).

The epithet *vulgatum* has been generally applied to southern African species of *Ophioglossum* that are morphologically very similar to the north temperate *O. vulgatum* L. During a recent study of the genus in Africa, numerous SEM photographs have been made of spores of the southern African taxon, which has revealed a striking difference in spore morphology between the northern and southern hemisphere taxa. The spore morphology of *O. vulgatum* has been well documented in Europe (Paul 1987; Ferrarini *et al.* 1986) and Asia (Kurita 1981; Nakamura & Shibasaki 1959; Pant & Misra 1975). All these studies reveal spore ornamentation characterised by a very irregular and coarse reticulum of muri rising up to shallow points resulting in a distinctly jagged profile.

In contrast, all the spores of the southern African taxon examined have a relatively uniform and fine reticulum which, in profile, is smooth (Figure 2J, K), lacking the jagged reticulum of the northern hemisphere taxon. Spore size, however, does not differ greatly [southern Africa: (27–)33–45(–60) μ m; Europe/Asia: (28–)34–40(–47) μ m] although the southern African material tends to be slightly larger.

Pocock, in her unpublished manuscript on southern African *Ophioglossum*, describes the southern African material of *O. vulgatum* as a subspecies of the typical material, based, as she puts it, 'largely upon geographical considerations'. This, in itself, is not sufficient grounds for taxonomic distinction; however, the additional information now available on spore morphology supports this separation, and the southern African material (none of the specimens examined for spore pattern have shown any resemblance to the northern hemisphere subspecies) is now regarded as a separate subspecies. Spores of *O. vulgatum* from East Africa have not yet been examined.

Selected specimens examined

Note: specimens of which spores have been examined by SEM are marked with an asterisk *.

ZIMBABWE.—1731 (Harare): Domboshawa, (–CA), 26-3-1983, Burrows 3037 (SRGH, J.E.B. Herb.). 1828 (Gokwe): Gokwe Dist., Sengwa Wildlife Research Area, Froggy Pond, (–AA), 10-2-1991, Burrows & Burrows 5144* (K, MICH, NU, PRE, SRGH, TI); Leguaan Vlei, (–AA), 11-2-1991, Burrows & Burrows 5155* (J.E.B. Herb., TI). 1832 (Mutare): Nyanga National Park, (–BD), 16-1-1951, Chase 3758* (BM, BOL, SRGH). 1932 (Melsetter): Chimanimani Mts, Bundi Plain, (–DD), 26-10-1959, Goodier & Phipps 280 (BM, PRE, SRGH).

TRANSVAAL.—2230 (Messina): Funduzi, (–CD), 21-1-1931, Bremekamp & Schweickerdt 321 (PRE). 2328 (Baltimore): Blouberg, (–BB), 11-1-1955, Codd & Dyer 8979 (PRE). 2430 (Pilgrim's Rest): Graskop, The Pinnacle, (–DD), 2-1-1961, Braithwaite 203* (BOL). 2530 (Lydenburg): 0.25 km N of Sabie, (–BB), 30-12-1990, Burrows & Burrows 5122* (K, MICH, PRE, TI); Kaapsehoop village, (–DB), 19-12-1990, Burrows & Burrows 5093* (K, MICH, PRE, TI).

NATAL.—2730 (Vryheid): Utrecht, (–AD), 3-11-1985, Devenish 1884 (PRE). 2929 (Underberg): Fort Nottingham Commonage, (–BD), 30-10-1987, Goldblatt & Manning 8510 (MO, PRE). 2930 (Pietermaritzburg): New Hanover/Mapumulo, Kingcliff, (–BD), 5-1-1965, Moll 1519 (PRE). 3029 (Kokstad): Alfred Dist., Weza, southern slopes of Ingeli Mtn, (–DA), 2-1-1966, Strey 6395 (BR, K, NU, PRE).

4. *Ophioglossum rubellum* Welw. ex A. Br. in Kuhn, Filices africanæ: 179 (1868); Hook. & Bak.: 445 (1868); Prantl: 321 (1884); Clausen: 152 (1938); Tardieu-Blot: 23 (1953); Faden: 25 (1974); Schelpe: 33 (1977); Johns: 10 (1991). Type: Angola, Pungo Andongo, near Catete, Welwitsch 33 (K, lecto.!; BM!, LISU, iso.).

As with most of Welwitsch's collections of *Ophioglossum*, his No. 33, the type of *O. rubellum*, is composed of a number of collections gathered at different localities in the Pungo Andongo District during January and February 1857. The sheet in BM and one of the two sheets in K both consist of more than one gathering. Clausen, in 1946, annotated the one sheet in K as 'Type', although he never published a lectotypification. There are, however, two (apparently) different collections on the Kew sheet. In order to avoid confusion, the group of four plants mounted above Welwitsch's printed label at the bottom of the sheet at Kew (already annotated as the type by Clausen) is hereby selected as the lectotypic element for the name of the species.

Distribution: Guinea (?), Sierra Leone, Ghana, Nigeria, Central African Republic, Ethiopia, Uganda, Kenya, Tanzania, Gabon, Angola, Zambia, Zimbabwe, South Africa (Transvaal).

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Systematic studies in the genus *Mohria* (Anemiaceae: Pteridophyta). IV. Comparative gametophyte morphology in *Mohria* and *Anemia*

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Keywords: *Anemia*, Anemiaceae, gametophyte, *Mohria*, morphology, Pteridophyta

ABSTRACT

The sporophyte morphology in *Mohria* and *Anemia* (Anemiaceae) is dissimilar. However, similarities in their anatomy, trichomes, spores and chromosome numbers show clearly that these genera are related. The contribution of the gametophyte to the classification and phylogeny of the Pteridophyta is largely neglected. The gametophyte of Anemiaceae is primitive in many features when compared with that of other leptosporangiate ferns. The prothallus of *Mohria* is considered more advanced than that of *Anemia* in the germination pattern of the spores, the presence of mycorrhiza in the cushion, the permanently lateral position of the meristematic region and the simpler trichome types.

UITTREKSEL

Die sporofiet van *Mohria* en *Anemia* (Anemiaceae) verskil morfologies van mekaar. Ooreenkomste in hul anatomie, trigome, spore en chromosoomgetalle toon egter duidelik dat hierdie genusse verwant is. Die gametofiet van Anemiaceae is in baie opsigte primitief wanneer dit met dié van ander leptosporangiate varings vergelyk word. Die protallus van *Mohria* word as meer gevorderd beskou as dié van *Anemia* in die ontkiemingspatroon van die spore, die teenwoordigheid van mikorisa in die protalluskussing, die meristematiese streek wat permanent in 'n laterale posisie bly en die meer eenvoudige trigoomtipes.

INTRODUCTION

Mohria Swartz, together with *Anemia* Swartz, *Schizaea* J. Smith, *Actinostachys* Wall. and *Lygodium* Swartz are commonly placed in a single family, the Schizaeaceae (Engler & Prantl 1898–1902; Bower 1923; Christensen 1938; Copeland 1947; Tryon & Tryon 1982; Tryon & Lugardon 1990), because of their exindusiate, mono-sporangiate sori and characteristic apical ring of annulus cells. Eggert & Delevoryas (1967) have shown, however, that 'schizaeaceous' sporangia evolved independently in coenopterid derivatives that are quite unrelated to the schizaeoid ferns. *Senftenbergia* Corda, formerly included in the Schizaeales (Reed 1947) because of its apical annulus, has been noted to occur on zygopterid foliage (Mickel 1974). This sporangium type therefore appears to be polyphyletic in origin. The subdivision of the schizaeoid assemblage into distinct families, Anemiaceae (*Anemia* and *Mohria*), Lygodiaceae (*Lygodium*) and Schizaeaceae (*Schizaea* and *Actinostachys*) has recently gained wider acceptance (Nayar 1970; Bierhorst 1971; Löve *et al.* 1977; Clifford & Constantine 1980; De la Sota & Morbelli 1987).

Although *Anemia* and *Mohria* are dissimilar in morphology they are evidently related in view of similarities in their anatomy (Prantl 1881; Bower 1918; Roux *et al.* 1992), trichomes (Mickel 1962; Roux 1992a), spores (Mickel 1962; Hill 1977, 1979; Dettman & Clifford 1991; Roux 1992b) and chromosome numbers ($n = 38, 76$).

Bower (1923) discouraged the use of gametophyte morphology in pteridophyte classification. However, studies in that field were continued and results have proven

useful as taxonomic and phylogenetic tools. The purpose of the present study is to summarize previously published work, and to extend the information on the anatomy and morphology of the prothallus. All the information relevant to the prothallus of *Mohria* is synthesized and analysed.

MATERIAL AND METHODS

Anatomical studies were carried out on prothalli collected in the wild. Wax embedding was done using standard techniques (Johansen 1940). Serial sections 8–10 μm thick were taken with a rotary microtome and stained with fast green and safranin. Photography was done with a Zeiss 'Axoscop' fitted with a M35W camera. Ilford PanF film was used throughout.

SEM studies were done on spores cultivated on clay pots. The prothalli were critical-point dried using CO_2 as a transitional fluid. Specimens were affixed to aluminium stubs using glue and sputter coated with Au/Pd and were viewed in a Cambridge S200 SEM at 5 kV.

Specimens examined

Mohria caffrorum (L.) Desv., 3318 (Cape Town): Stellenbosch, (–DD), Roux 2363.

M. marginalis (Sav.) J.P. Roux, 2829 (Harrismith): Cathedral Peak, (–CC), Roux 2297.

M. vestita Bak., 2430 (Pilgrim's Rest): Graskop-Sabie rd. (–DD), Roux 2236. 2630 (Carolina): Swaziland, (–DB), Roux 2261.

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Voucher specimens are all deposited in the Compton Herbarium (NBG).

RESULTS AND DISCUSSION

Prothallial development

Spore germination

Atkinson (1960, 1962), based her observations on spore germination in *Mohria* and *Anemia* on whole mounts and found the pattern in both these genera to be identical. Atkinson (1960, 1962) recorded the first division of the spore protoplast to be in an equatorial plane, forming an apical cell at the proximal pole, this being the pole bearing the triradiate scar, and a distal cell at the distal pole. With the second division the apical cell divides at a right angle to the first to form a larger green prothallial cell and a smaller, almost colourless, rhizoidal cell (Figure 1). Nayar & Kaur (1968, 1971) categorised this germination pattern as polar and more specifically as the *Anemia*-type.

Observations made by Raghavan & Huckaby (1980) on sectioned material are in conflict with those of Atkinson (1960, 1962). They convincingly showed that in *Mohria* the first division is in an equatorial plane resulting in a larger distal cell at the distal pole and a smaller rhizoidal cell at the proximal pole. With the second division, however, it is the distal cell that divides to form a larger distal cell and a smaller protonemal cell (Figure 1). This pattern corresponds with the *Osmunda*-type of polar germination as defined by Nayar & Kaur (1968, 1971).

Raghavan & Huckaby (1980) found *Mohria* and *Anemia* to be dissimilar. In *Anemia*, as in *Mohria*, the first division is in an equatorial plane giving rise to a larger distal cell at the distal pole. However, at the proximal pole a smaller protonemal cell is formed. With the second cellular division the distal cell divides to form a larger distal cell and a smaller rhizoidal cell (Figure 1). This pattern of spore germination does not fit into the scheme of Nayar & Kaur (1971).

The distinct modes of germination in *Mohria* and *Anemia* probably indicate different trends of specialization which is also evident in the sporophyte morphology. The origin of the rhizoid and protonemal cell in *Mohria* by a route similar to that seen in genera considered advanced, confirm its specialized status.

Prothallial development in *Mohria* (Bauke 1878; Atkinson 1960) and *Anemia* (Momose 1949; Twiss 1910; Kaur 1961; Atkinson 1962) is known in some detail and shows no differences which may be of any significance. Following the formation of the prothallial cell it continues to grow and divide by transverse divisions producing a filament five to six cells long. Longitudinal divisions are soon evident in cells behind the apex and these continue both in an anterior and posterior direction. Vertical, longitudinal and oblique divisions take place and the position of the localized dividing area in relation to the rest of the expanding but less rapidly growing gametophytes determines the shape of the early cellular plate. The margin of the prothalli may be variously lobed. I often found unicellular trichomes to be associated with the sinuses. A true apical initial is evidently never formed. A large wing is eventually formed with the more rapidly dividing meristem in a lateral position which, in *Mohria*, is maintained throughout the life of the plant. Circumstances contributing to the lateral position of the meristem can be ascribed to the anticlinal divisions which are more numerous than periclinal divisions. Also no wing is formed on the proximal side of the meristem but only hairs and gametangia. Divisions in a third plane give rise to a cushion directly behind the meristem. The gametophyte grows at first more or less parallel to the substrate but as the cushion continues to develop the thallus assumes an oblique position supported by long rhizoids. In *Mohria* the prothallus eventually becomes upright.

Mature prothallus

In the mature prothallus of *Mohria* the lateral meristem remains hidden by the continued development of the voluminous spiralling wing (Figure 2A). The older basal parts of the wing eventually turn brown as the thallus grows upwards. Marginal areas of all but the last formed parts of the wing are irregular in outline. The wings are one cell layer thick except close to the cushion where it may be two cells thick. As growth continues the massive cushion grows upwards and appears as a column. Small flaps of sterile tissue often appear on the cushion. These flaps of tissue may become winglike and aid in photosyn-

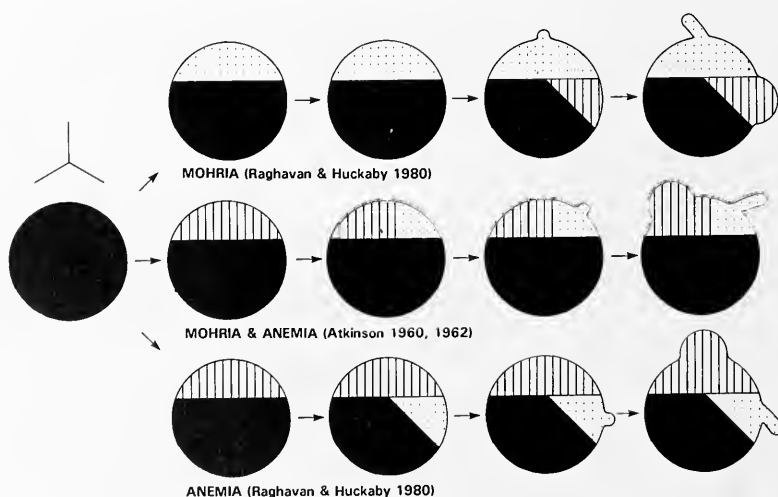


FIGURE 1.—Spore germination patterns in *Mohria* and *Anemia* as observed by Atkinson (1960, 1962) and Raghavan & Huckaby (1980). Dark-coloured = spore or distal cell; vertical lines = protonemal cell; dots = rhizoidal cell.

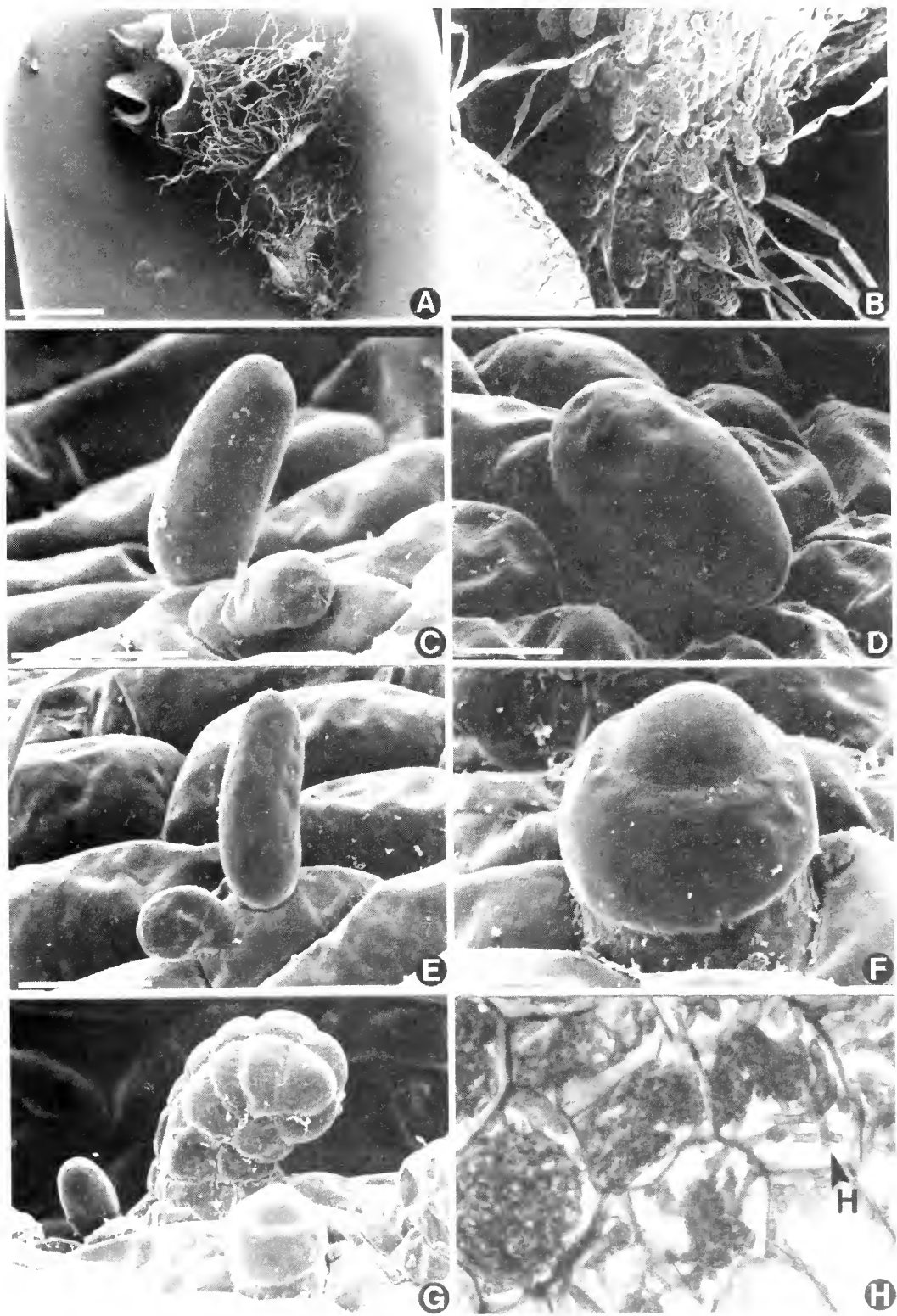


FIGURE 2.—Prothallus and prothallial structures in *Mohria vestita*, Roux 2261. A: mature prothallus showing spirally formed wing; B: prothallus cushion showing interspersed antheridia, archegonia and trichomes; C: three-celled hair on prothallus wing; D: unicellular hair on prothallus wing; E: two-celled hair on prothallus wing; F: mature antheridium on abaxial surface of prothallus cushion; G: archegonium on abaxial surface of prothallus cushion; H: cushion of *M. vestita*, Roux 2236, prothallus showing endofungal hyphae (H1). Scale bars: A, 2 mm; B, 500 μ m; C, E, 50 μ m; D, F, 20 μ m; G, 100 μ m; H, \times 1000.

thesis. Antheridia, although mostly confined to the posterior regions of the thalli may occur interspersed with archegonia (Figure 2B & G) which are formed later than the antheridia. As the columnar cushion increases in height, archegonia and hairs continue to be formed in great numbers. Abundant rhizoids are formed on the cushion. Older rhizoids are brown, long and stiff and continue to be produced along the columnar cushion. Mature thalli of *Mohria* are chlorophyllous and mycorrhizal (Figure 2H) with the mycorrhiza restricted to the ventral side of the cushion. The endophytic fungus evidently plays only a minor role in the nutrition of the thallus, as in cultivated material, where the fungus is absent, the thalli show no adverse effects.

In *Anemia*, cells on the proximal side of the meristem grow outwards until a small wing is formed. As this wing becomes larger, the meristem is carried into a vertical position and the only indication of an earlier lateral meristem is the inequality of the wings. This change in position of the meristem is accompanied by the development of a thick cushion bulging towards the ventral side, and by uplifting and recurving of the wings over the dorsal surface of the cushion (Atkinson 1962). Unlike *Mohria* the near vertical position of the prothallus is not maintained. In *Anemia* the thalli are elongate-cordate in form, more or less prostrate in position, green at the anterior end and dying off behind. Rhizoids and archegonia are produced in great numbers on the ventral surface of the cushion.

Nayar & Kaur (1971) suggested the more primitive thallus to be dorsiventral with a massive median midrib and heavy wings several cells thick near the midrib but progressively becoming one cell layer thick towards the margins. In this respect the prothalli of *Mohria* and *Anemia* can be considered primitive. A step in advancement in *Mohria* and *Anemia*, however, is the elimination of the apical initial and the development of a multicellular meristematic region. Nayar & Kaur (1971) furthermore suggested that among those genera with a thalloid-cordate type gametophyte, the most primitive is the symmetrical type. In *Anemia* the prothallus is temporarily asymmetrical but later becomes symmetrical. The gametophyte of *Mohria* remains permanently asymmetrical and is therefore considered more advanced.

Prothallial trichomes

The thallus of *Mohria* bears small one- to three-celled hairs (Figure 2C) on the wing and cushion surfaces among the antheridia and archegonia. Atkinson (1960) found most hairs in older thalli to occur mainly on the surface of the cushion. My observations, however, showed that the cushion is not significantly more hairy than the wings. Unicellular trichomes, up to 60 µm long, similar to the naviculate trichomes found on the fronds of the sporophyte (Roux 1992a), are the most common type in *Mohria* and occur on the wings as well as on the cushion (Figure 2D). Two-celled hairs common on young thalli, have previously been described by Bauke (1878) and Stokey (1960). The outermost colourless cell is at least twice as long as the basal cell. A chlorophyllous basal cell very frequently bears two colourless cells (Figure 2E). This was also reported by Bauke (1878) and Atkinson (1960). These cells are usually of unequal size. Atkinson (1960) also

reported branched hairs and hairs up to three cells long from the wings.

One- to four-celled hairs also occur on mature prothalli in *Anemia*. At first, the hairs are marginal, developing from a cell adjacent to the meristem. As in *Mohria*, the basal cell of two-celled hairs is chlorophyllous and the outer cell colourless. Marginal multicellular hairs have been reported in some *Anemia* (*A. adiantifolia*, *A. aurita*) species (Atkinson 1962).

Prothallial trichomes have been considered of little value in taxonomic and phylogenetic studies (Stokey 1951, 1960; Atkinson & Stokey 1964) because similar trichome types occur in apparently unrelated groups of ferns, a situation that may be ascribed to parallel evolution. Nevertheless Nayar & Kaur (1971) suggest that the restricted distribution of hairy prothalli among the various phyletic groups may be of value in comparative studies. Naked prothalli appear to be the more primitive condition among the homosporous ferns. Unicellular hairs are more common in advanced families such as Polypodiaceae, Davalliaceae, Lomariopsidaceae and Grammitidaceae and are usually secretory (Nayar & Kaur 1971). The prothallus of Schizaeaceae is either subterranean or terrestrial and is devoid of any trichomes. In *Lygodium* the prothallus has been described as naked (Bauke 1878; Twiss 1910) but a few clavate trichomes have been reported for *L. flexuosum* (L.) Swartz (Nayar & Kaur 1971, *contra* Mahabale & Kulkarni 1949). I have observed clavate trichomes in a marginal position in cultured prothalli of *L. japonicum* (Thunb.) Swartz. In the Anemiaceae, however, non-secretory, often multicellular trichomes occur.

Gametangia

Antheridium

Antheridia are formed on the margins and ventral surfaces of the thallus in the region of the meristem. They are produced in great numbers on the cushion and may extend to the wing. Antheridia in *Mohria* and *Anemia* are similar in ontogeny and morphology. Atkinson (1960, 1962) described the antheridium as developing from a superficial initial. A thin disc-shaped cell is cut off from the antheridial initial to form a proximal ring cell and a distal terminal cell. This is followed by the formation of a dome-shaped wall which divides the terminal cell into an outer wall or ring cell and an inner primary spermatogenous cell. A division of the ring cell gives rise to the cover cell of the antheridium. The antheridium structure is thus typical of the leptosporangiate ferns (Figure 2F). Successive division of the spermatogenous cell gives rise to a small number of sperm. In *Mohria* and *Anemia* each spermatozoid is contained within a cell wall at the time of release (Atkinson 1960; Nester 1985). At dehiscence the cover cell is shed explosively and the spermatocytes emerge one by one through a pore.

Archegonium

My observations in the ontogeny of the archegonium in *Mohria* conform with those of Atkinson (1960). Archegonia are borne on the abaxial side of the cushion only. In mature archegonia I found the archegonial neck, which

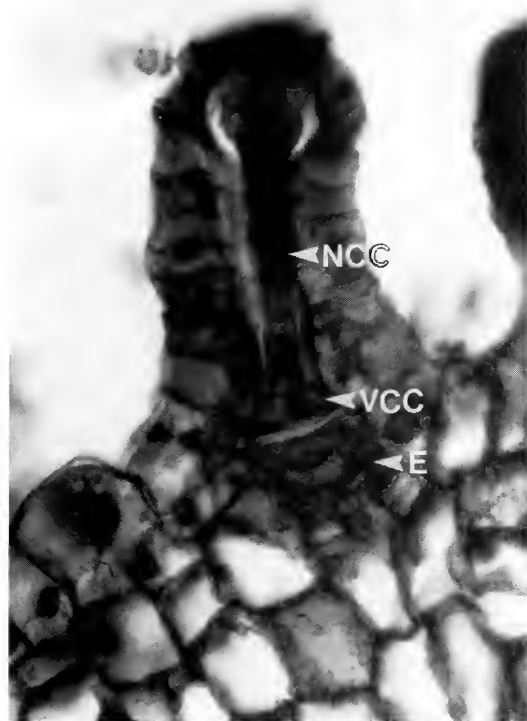


FIGURE 3.—Section through archegonium of *Mohria marginalis*, Roux 2297, $\times 400$. E, egg cell; NCC, neck canal cell; VCC, ventral canal cell.

consists of four cells and up to eight tiers high (Figure 2G), to curve in the direction of the substrate (Figure 2B), a system which would be advantageous to the fertilization process. Prior to the opening of the archegonium the distal part of the neck becomes bulbous and the neck canal cell contorts to form a globular mass containing two to four nuclei (Figure 3) confirming Atkinson's (1960) observations. The venter is well embedded in the cushion and is surrounded by a layer of small cells containing a dense protoplasm. Ontogenetically and structurally the archegonia in *Mohria* and *Anemia* are similar.

Nayar & Kaur (1971) described an advanced archegonium as having a neck consisting of three to four tiers of cells high, which curve away from the apex and possess an undivided neck canal cell. Archegonia in Anemiaceae thus conform largely with the primitive type.

Embryogenesis

The division of the zygote has not been observed by me or by Atkinson (1960, 1962). De la Sota & Morbelli (1987), however, claim it to be of the 'leptosporangiate' type, in which the first division is longitudinal or parallel to the main axis of the archegonium.

The young embryo of *Mohria* is protected by a well-developed calyptra (Figure 4A). Initially only the foot and the stem can be identified. The foot is well embedded in

the ground tissue of the prothallus cushion. The young embryos I examined showed the frond to differentiate before the root. The stem soon developed an apical initial with three cutting faces. The primary root developed endogenously and contained a large apical initial and a well-defined rootcap even before breaking through the cortical tissue of the stem (Figure 4B).

Like Atkinson (1960) I also found prothalli attached to young sporophytes containing up to five fronds. Sections through these prothalli show that the cell walls separating the foot from the prothallus tissue thicken and form an abscission layer. Mycorrhiza were also observed in tissue

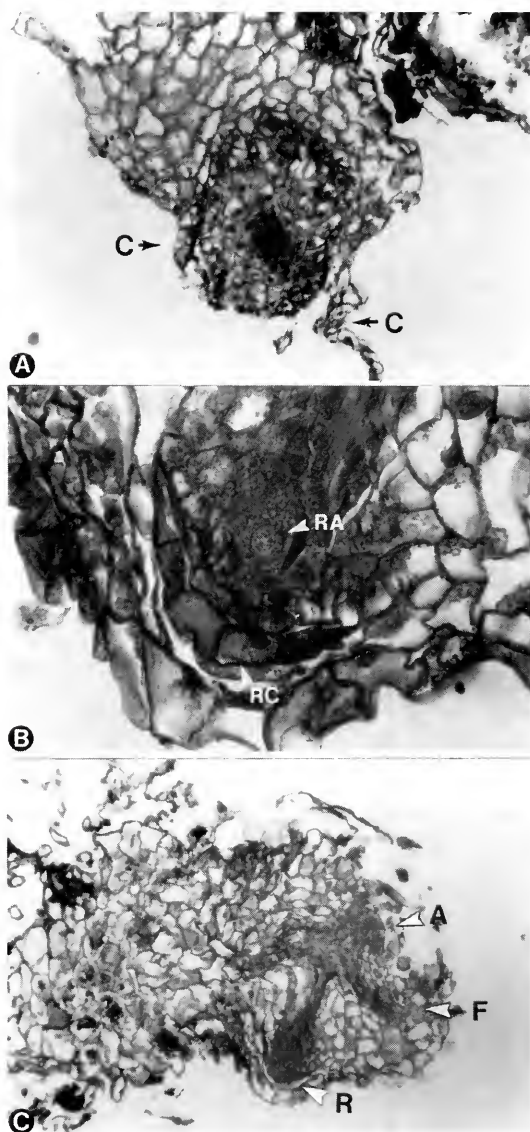


FIGURE 4.—Transverse sections of embryo in *Mohria vestita*, Roux 2236. A, young embryo showing calyptra (C), indicated by arrows, $\times 68$; B, first root before breaking through prothallus tissue showing root cap and large apical initial, $\times 270$; C, prothallus of a developing young plant with first root, frond and shoot apex, $\times 68$. A, apical initial; C, calyptra; F, frond; R, root; RA, root apex; RC, root cap.

of the young sporophyte, especially the stem and roots, as well as in the tissues of the gametophyte.

Vascular tissue in the root, stem and frond is formed at an early stage (Figure 4C). Initially the tracheids show spirally arranged secondary thickenings but later pitting is of the scalariform or reticulate scalariform type.

CONCLUSIONS

Classification and phylogeny of the Pteridophyta is largely based on the dominant sporophyte generation. The small, usually overlooked, gametophyte generation or prothallus may, however, also contribute to the understanding of the evolutionary processes and phylogeny of the ferns. Bower (1923) and Holttum (1949), cautious of the effects of external influences during the development of the prothallus, realised the meagre but important contribution it can make with a view to classification.

Stokey (1951) and Nayar & Kaur (1971) suggested possible evolutionary trends in the structure of the prothallus and gametangia. Features that are considered advanced in the prothallus of the leptosporangiate ferns are: a small, short-lived, autotrophic, symmetric, cordate thallus with a centrally situated meristematic region and poorly developed midrib. Trichomes are present but are simple, unicellular and secretory. The antheridium is a three-cellular structure, consisting of a basal, ring and cap cell. The cap cell dehisces in its entirety and the antheridium has a small sperm output. The archegonia are small, form later than the antheridia, and are situated closer to the meristematic region. The mature archegonium has a neck that curves away from the meristem and consists of up to four tiers of cells. The neck canal cell is undivided.

Considering these changes, the prothallus of Anemiaceae is in many respects phylogenetically primitive, a feature which is also expressed in many morphological features of the sporophyte. On grounds of the sporophyte, *Mohria* is considered phylogenetically more advanced than *Anemia* (Bower 1923; Mickel 1962). The permanently laterally placed meristematic region and the absence of multicellular hairs from the prothallus are supportive of such an assessment.

It is thus evident that the prothallus can make an important contribution to an understanding of the phylogeny of the Pteridophyta at the family as well as at the generic level.

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Synopsis of the genus *Disparago* (Asteraceae)

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Keywords: Asteraceae, *Disparago*, new sections, synopsis, taxonomy

ABSTRACT

The genus *Disparago* comprises nine very distinct species and is here divided into four new, well-defined sections: **Monticapra** Koekemoer, comprising three recently described species, *Disparago gongylodes* Koekemoer, *D. barbata* Koekemoer, *D. pilosa* Koekemoer; section **Laevicarpa** Koekemoer (*D. kolbei*) and section **Uniflos** Koekemoer (*D. tortilis*) which are both monotypic, and section **Disparago** which has four species (*D. ericoides*, *D. anomala*, *D. kraussii*, *D. laxifolia*). The previous revision (Levyns 1936a) included seven species of which six are retained. A key to the sections and the species and a diagrammatic key are given as well as diagnostic descriptions, synonyms, typification and notes on the distribution and habitat of each species.

UITTREKSEL

Die genus *Disparago* bestaan uit nege baie duidelike spesies en word hier verdeel in vier nuwe, goed omskryfde seksies: **Monticapra** Koekemoer, met drie onlangs beskryfde spesies, *Disparago gongylodes* Koekemoer, *D. barbata* Koekemoer, *D. pilosa* Koekemoer; seksie **Laevicarpa** Koekemoer (*D. kolbei*) en seksie **Uniflos** Koekemoer (*D. tortilis*) wat albei monotipes is en seksie **Disparago** met vier spesies (*D. ericoides*, *D. anomala*, *D. kraussii*, *D. laxifolia*). Die vorige hersiening (Levyns 1936a) het sewe spesies ingesluit waarvan ses behou word. 'n Sleutel tot die seksies, die spesies en 'n diagrammatiese sleutel word gegee sowel as diagnostiese beskrywings, sinonieme, tipifikasie en notas oor die verspreiding en habitat van elke spesie.

INTRODUCTION

The genus *Disparago* is confined to South Africa and occurs in the fynbos of the southwestern Cape. It now comprises nine species: six retained from the previous revision (Levyns 1936a) and three recently described (Koekemoer 1991). The genus is remarkable in many ways—the biogeography, morphology, evolutionary development and speciation (Koekemoer in prep. a, b). There are many unanswered questions about *Disparago* and the genus holds challenging clues to a better understanding of the fynbos flora.

Disparago Gaertn., Fructibus et seminibus plantarum 2: 463, t. 173 (1791); DC.: 257 (1837); Cass.: 348 (1819); Less.: 362 (1832); Benth. 323 (1873); Harv.: 277 (1894); Schltr.: 203 (1900); Levyns: 95 (1936a); Dyer: 682 (1975). Type species: *Disparago ericoides* (Berg.) Gaertn. (= *Stoebe ericoides* Berg.).

Wigandia Neck.: 95 (1790) non Kunth; Less.: 362 (1832).

Seriphia et *Stoebes* spp. auctt.

The name *Disparago* is listed as conserved, although conservation against *Wigandia* was superfluous (Rickett & Stafleu 1960).

Shrubs or shrublets, usually profusely, sympodially branched, larger plants dense, upright or cushion-like and spreading; new shoots developing from below terminal

inflorescence of previous season. *Leaves* alternate, small, filiform, oblong or obovate; adaxial surface villous, hairs unicellular; margins entire, involute; apex mucronate, apiculate or obtuse. *Synflorescences* terminal. *Heads* solitary, in small clusters or in very dense globose, subglobose or cylindrical aggregations; 1-flowered or up to 10-flowered; individual heads homogamous or heterogamous, composed of ray and/or tubular flowers. *Involucre* in 1–4 series, chaffy, lacking a distinct stereome, broadly or narrowly cymbiform; apices acute or acuminate; margins entire, sometimes undulate or with clavate outgrowths. *Ray flowers* 3-lobed, female or sterile, white or pink, ray 1.5–4.0 × 1.2–3.0 mm; cypselas fertile or sterile; surface glabrous, puberulous or villous. *Tubular flowers* 5-lobed, lobes erect or spreading star-like, male or hermaphrodite, white or pink; cypselas fertile or sterile, surface glabrous, puberulous or villous. *Pappus* present or absent, caducous or persistent, 3–15(–20), plumose or barbed bristles, free or connate in a ring or tube at base.

Distribution: the main area of distribution is the fynbos of the southwestern Cape, a winter rainfall area. One species, *D. tortilis*, is more widely distributed and spreads along the south and east coast to Umtamvuna in Natal where it occurs in relict fynbos areas. In the western Cape the genus does not occur further north than the Great Winterhoek mountains near Porterville. The inland boundaries of its distribution are along the mountains bordering the karoo or the transition between fynbos and other biomes.

DISCUSSION

The original generic description by Gaertner (1791) included only species now accommodated in the section *Disparago*. The generic description given above was

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therefore expanded to include all the other species subsequently found.

Disparago can be distinguished from its closest relatives, *Stoebe* and *Elytropappus*, by the presence of ray flowers in some/all the heads of the synflorescence. Although the monotypic genus *Bryomorpe* also has ray flowers, it is distinguished by a moss-like habit. The leaf morphology of *Disparago* is very similar to that of *Stoebe* and it is therefore very difficult to identify sterile material. Most species of *Elytropappus* can be distinguished by the presence of glands on the leaves. Generic and infrageneric relationships will be discussed in a separate paper (Koekemoer in prep. a).

SPECIES TREATMENT

The genus *Disparago* can be divided into four natural groups which are here treated as sections. Section **Monticapra**: *D. gongylodes*, *D. barbata*, *D. pilosa*. Section **Laevicarpa**: *D. kolbei*. Section **Uniflos**: *D. tortilis*. Section **Disparago**: *D. anomala*, *D. ericoides*, *D. kraussii*, *D. laxifolia*.

Key to sections

- 1a Ray flowers sterile or reduced section **Disparago**
- 1b Ray flowers female:
 - 2a Heads 1-flowered section **Uniflos**
 - 2b Heads 5–8-flowered:
 - 3a Cypselas of both ray and tubular flowers fully developed; tubular flowers hermaphrodite section **Laevicarpa**
 - 3b Cypselas of ray flowers fully developed, those of tubular flowers reduced; tubular flowers male . section **Monticapra**

In the two monotypic sections (*Uniflos* and *Laevicarpa*), the cypselas of both the ray and tubular flowers are fertile. The main differences between the sections are in the cypselas surface, the number of flowers per head and the arrangement of heads. Species in the section *Monticapra* have inflorescences similar to those of *Bryomorpe* and further investigation is needed to determine whether *Bryomorpe*, a monotypic genus, should be given generic status.

Key to species (see also diagrammatic key in Table 1)

- 1a Ray flowers female, cypselas fully developed:
 - 2a Heads 1-flowered 5. *D. tortilis*
 - 2b Heads 5–8(–10)-flowered:
 - 3a Cypselas fully developed in ray and in tubular flowers ...
 - 4a Leaves obovate 1. *D. gongylodes*
 - 4b Leaves linear or lanceolate:
 - 5a Pappus plumose, connate at base; leaves spreading; involucre tomentose 3. *D. pilosa*
 - 5b Pappus barbed, loose; leaves appressed; involucre smooth 2. *D. barbata*
 - 3b Cypselas fully developed in ray flowers, sterile in tubular flowers:
 - 6a Cypselas surface woolly 7. *D. ericoides*
 - 6b Cypselas surface puberulous:
 - 7a Pappus absent 6. *D. anomala*
 - 7b Pappus present:
 - 8a Leaf tips obtuse; leaves more than half their length apart, mostly spreading; west of 20 degrees longitude; flowering in spring 9. *D. laxifolia*
 - 8b Leaf tips mucronate; leaves less than half their length apart, mostly appressed at least near inflorescence; east of 20 degrees longitude; flowering in autumn 8. *D. kraussii*

TABLE 1.—Diagrammatic key to the species of *Disparago*

	Alt. (m)	Flow. time	Synflor.	No. flow./head	Ray flowers	Tubular flowers	Cypselas		Pappus
							Ray flow.	Tub. flow.	
<i>D. gongylodes</i>	1200–1600	spring	semi-globose	± 7	female	functionally male	woolly	reduced	2–3 hairs caducous plumose
<i>D. barbata</i>	1500	spring	semi-globose	± 6	female	functionally male	puberulous	reduced	2–3 hairs caducous barbed
<i>D. pilosa</i>	1500	spring	semi-globose	± 8	female	functionally male	puberulous	reduced	± 10 hairs coalescent plumose
<i>D. kolbei</i>	1200–1900	spring	loose grouping of heads	4–6	female	hermaphrodite	glabrous	glabrous	8–12 hairs coalescent plumose
<i>D. tortilis</i>	0–1500	after rainy season	globose	1	female	hermaphrodite	puberulous	puberulous	5(–20) hairs not coalescent plumose
<i>D. anomala</i>	0–500	autumn	globose	2	sterile	hermaphrodite	reduced	puberulous	absent
<i>D. ericoides</i>	0–600	autumn	globose to roughly globose	2	sterile	hermaphrodite	reduced	woolly	15–20 hairs coalescent plumose
<i>D. kraussii</i>	0–300	autumn	globose	2	sterile	hermaphrodite	reduced	puberulous	(3–)5(–8)hairs not coalescent plumose
<i>D. laxifolia</i>	0–550	spring	globose	2	sterile	hermaphrodite	reduced	puberulous	5 hairs not coalescent plumose

Sectio 1. **Monticapra** Koekemoer, sect. nov., capitula heterogama, 5–8-flora; flores radii feminei; flores disci fungentes masculini; flores radii albi, flores disci vinacei; cypselae florum radii fertiles, florum disci steriles. Ad altitudines altas limitata. Typus sectionis: *D. gongyloides* Koekemoer.

Capitula heterogamous, 5–8-flowered; ray flowers female; tubular flowers functionally male; ray flowers white, tubular flowers wine-red; cypselas fertile in ray flowers, sterile in tubular flowers. Confined to high altitudes.

The name *Monticapra* was chosen in honour of Miss E. Esterhuysen (with all due respect), who like a 'mountain goat' explored remote mountains to discover the three species in this section.

1. **Disparago gongyloides** Koekemoer in Bothalia 21: 158 (1991). Type: Cape, Great Winterhoek Wilderness Area, Esterhuysen 35788 (BOL, holo.!; NBG!, K!, PRE (2x)!, S!, STE!).

Shrublets (50–)100–350 mm tall, profusely branched mainly from base. *Leaves* obovate, 2.5–3.5(–5.0) × 1–2 mm, involute at margins only, adaxial surface villous, apex obtuse; pedicel twisted near base. *Synflorescence* of 5–12 heads in a loose arrangement. *Involucre* of about 12 bracts in three series, outermost series foliaceous, inner series broadly cymbiform, narrowing to the innermost series; dark brown, often with reddish tint, margins often undulate in upper half, apex acuminate and often reflexed. *Heads* composed of two ray flowers and five tubular flowers. *Ray flowers* white, female, rays 3–4 × 1.5–2.5 mm; cypselas fertile, surface woolly. *Tubular flowers* pink, male; cypselas sterile, surface puberulous. *Pappus* present in ray and tubular flowers, plumose, of 2 or 3 caducous hairs, not connate, capillaries in pappus tips inflated and these tips obtuse and loosely coalescent, tips of capillaries acute in lower part.

Distribution: this species is only known from one area: the top of the Great Winterhoek Mountain near Porterville (Figure 1) where it grows very abundantly on coarse Table Mountain Sandstone, on flat areas where small *Restio* species are dominant.

Specimens examined

CAPE.—3319 (Porterville) Great Winterhoek Reserve, (–AA), Esterhuysen 34840 (PRE, BOL), 35788 (BOL, K, NBG, STE); Twentyfour Rivers Mountains, (–AA), Esterhuysen 21894 (BOL, PRE); Great Winterhoek Mountains, Farm Berghof, (–AA), Koekemoer 315, 440 (PRE); Great Winterhoek Reserve, 2 km from Zuurvlakte entrance, (–AA), Koekemoer 439 (PRE).

2. **Disparago barbata** Koekemoer in Bothalia 21: 158 (1991). Type: Cape, Matroosberg, SE slopes, Esterhuysen 28615 (BOL 48345, holo.!; BOL 48346!, PRE!, S!).

Shrublets 200–400 mm tall, erect or trailing. *Leaves* filiform, 4–9 × 0.5–0.8 mm, spirally twisted, acute, spreading. *Synflorescence* of numerous heads crowded in ovoid secondary heads 10–15 mm in diameter, dark brown

and globular. *Heads* with three ray flowers and three tubular flowers. *Involucre* of about 12 bracts in 3 series, 4.5–6.0 × 0.6–1.3 mm, narrowly cymbiform, abaxial surface sparsely villous, margins entire, apex acuminate, often reflexed, usually tri-coloured: light brown near base, dark brown towards apex and tinted red in centre. *Ray flowers* female, ray 2.0–2.5 ± 1.5 mm, white; cypselas fertile, puberulous, dorsiventrally flattened. *Tubular flowers* functionally male, purple-red; cypselas sterile, puberulous. *Pappus* present in ray and tubular flowers, of 2 or 3 bristles, barbed, caducous, not connate.

Distribution: this species is only known from the Matroosberg near De Doorns in the southwestern Cape (Figure 1).

Specimens examined

CAPE.—3319 (Worcester): Matroosberg SE slopes, (–BC), Esterhuysen 28615 (BOL, PRE, S); Matroosberg E slopes above De Doorns, (–BC), Esterhuysen 28119 (BOL).

3. **Disparago pilosa** Koekemoer in Bothalia 21: 159 (1991). Type: Cape, Roodeberg, near Matroosberg, N slopes, Esterhuysen 29721 (BOL 48349, holo.!; BOL 48350!, NBG!, PRE!, S!).

Shrublets, up to 250 mm tall, profusely branched from base, branches woolly or sparsely villous, appearing 4-angled because of leaf arrangement. *Leaves* lanceolate, 2–6 × 0.5–0.9 mm, appressed or slightly spreading, not spirally twisted. *Synflorescence* with secondary heads composed of a few heads, loosely grouped. *Heads* with 3 ray flowers and 5 tubular flowers. *Involucre* 11–13, in 2 or 3 series, outermost broadly cymbiform, decreasing in width to the inner series which can be filiform, margins undulate, sometimes with membranous edge, apex acuminate, sometimes reflexed, adaxial surface villous in lower half, bicolorous, yellow-brown in lower half, black-brown in upper half with reddish tint near apex. *Ray flowers* female, white, 2.5–3.5 × 1.5–2.0 mm; cypselas fertile, surface puberulous. *Tubular flowers* functionally male, reddish pink, often with glands on surface of lobes; cypselas sterile. *Pappus* present in ray and tubular flowers, plumose, of about 10 hairs, connate in a ring at base.

Distribution: this species has only been collected on Matroosberg, Roodeberg, Roelofsberg and at the foot of Bokkeveld Sneekop in the Worcester District (Figure 1). It is reported to occur in sand in rocky areas.

Specimens examined

CAPE.—3219 (Wuppertal): Ceres Dist., northern base of Roelofsberg, (–CC), Esterhuysen 34675 (BOL, S); Waboomsriver, Cold Bokkeveld, (–CC), Hanekom 624 (PRE). 3319 (Worcester) Ceres Dist., Rosendal & Bo-Rosendal, at foot of Bokkeveld Sneekop, (–AB), Esterhuysen 33928 (BOL, S); Ceres Dist., Roodeberg near Matroosberg, N slopes, (–BC), Esterhuysen 29721 (BOL, NBG, PRE, S); Matroosberg northern plateau, (–BC), Esterhuysen 27704 (BOL); Matroosberg near the top along pipeline, (–BC), Koekemoer 361 (PRE).

Sectio 2. **Laevicarpa** Koekemoer, sect. nov., capitula heterogama, 5–8-flora; flores radii feminei; flores disci hermaphroditi; flores et radii et disci: rosei; cypselae florum et radii et disci fertiles. Ad montes regionem

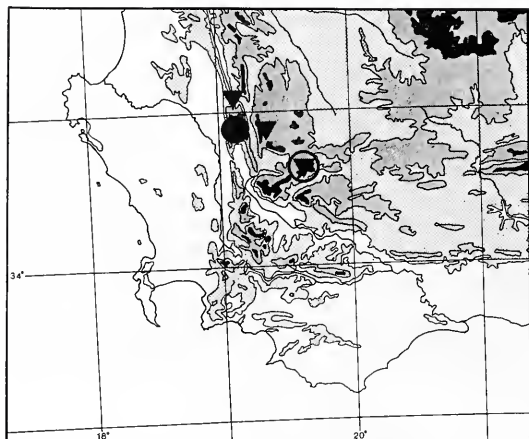


FIGURE 1.—Geographical distribution of *D. gongylodes*, ●; *D. barbata*, ○; and *D. pilosa*, ▼.

'Karoo' cognitam conterminos limitata. Typus sectionis: *D. kolbei* (H. Bol.) Hutch.

Capitula heterogamous, 5–8-flowered; ray flowers female; tubular flowers hermaphrodite; ray as well as tubular flowers pink; cypselas fertile in ray as well as tubular flowers. Confined to mountains bordering the Karoo.

The name *Laevicarpa* refers to the smooth surface of the cypselas in *D. kolbei*.

4. *Disparago kolbei* (H. Bol.) Hutch.: 511 (1932).

Amphiglossa kolbei Bolus: 394 (1909). Type: Cape, Oudtshoorn Dist., Swartberg Pass, Kolbe 1477 (BOL, holo!).

D. rosea Hutch.: 511 (1932); Levyns: 99 (1936a). Type: Cape, Uniondale Dist., hills near Avontuur, Fourcade 1663 (BOL 48241, lecto!, here designated; GRA!, PRE!, K).

The name *D. kolbei* was given to commemorate F.C. Kolbe, the collector of the type specimen and friend of H. Bolus.

Shrublets usually 100–300 mm tall, but old plants up to 700 mm tall and about 1.5 m in diameter. *Leaves* filiform to lanceolate, 2–4 × 0.3–0.5 mm, shorter leaves straight and appressed, longer leaves spirally twisted and spreading, often woolly. *Synflorescence* of 1–3(–5) heads. *Heads* with 2 or 3 ray flowers and 2 or 3 tubular flowers. *Involucre* of about 10 bracts in 3 series, outermost series ovate, about 1/3 as long as inner series of broadly cymbiform, light brown bracts. *Ray flowers* female, pink; cypselas fertile, surface glabrous, apical annulus usually well developed. *Tubular flowers* hermaphrodite, pink; cypselas identical to those of ray flowers. *Pappus* present in all flowers, of 8–12 plumose hairs, basally connate for about 1/5 of their length.

Distribution: this species is confined to the mountain ranges bordering the Karoo, stretching from Antoniesberg in the east to the Witteberge in the west (Figure 2).

Specimens examined

CAPE.—3320 (Ladismith): Witteberg, (–BC), Compton 2689 (BOL), 3335 (STE), 12201 (NBG); Esterhuysen s.n. (NBG); Goldblatt 3794 (K, PRE, S); Matjiesfontein, Witteberg near radio mast, (–BC), Van Zyl 3561 (PRE, STE); Anysberg, (–DA), Esterhuysen 17325 (BOL), 25986 (BOL, PRE); Koekemoer 305 (PRE); Marshall 19 (SAAS), 163 (STE); Van Wyk 1032, 1048 (PRE, STE); Van Zyl 3394 (PRE, STE); Vlok 451 (PRE, STE). 3321 (Ladismith): Elandsloof between Vleiland and Seweweekspoort, (–AD), Moffett & Steensma 3870 (STE). 3322 (Oudtshoorn): Swartberg Pass, (–AC), Bond 1556 (NBG); Esterhuysen 19683, 28823 (BOL); Hafströmi & Acocks 2338 (PRE, S); Koekemoer 299, 332 (PRE); Kolbe 1477 (BOL); Levyns 6655 (BOL); Markötter 9946 (STE); Schlechter s.n. (BOL); Stokoe 9070 (BOL), 58107 (SAM), 65910 (PRE, SAM), 64077 (SAM); Taylor 6974 (PRE, STE); Wall 277 (S); Swartberg, Hattinghskloof, (–AC), Thompson 1319 (PRE, STE); Swartberg, EVKOM-road on ridge, (–AC), Pienaar 38 (SAAS, STE). 3323 (Willowmore): Antoniesberg, N slopes, (–AD), Esterhuysen 24944 (BOL); Uniondale, hills near Avontuur, (–CA), Fourcade 1663 (BOL, GRA, PRE); Uniondale, hill N of Avontuur, (–CA), Fourcade 4611 (BOL, PRE, STE); Avontuur, hill NE of Avontuur, about 5 m from beacon, (–CA), Koekemoer 486 (PRE); Hoopsberg, accessed from Farm Hoogste Drift, lower slopes of western ridge, (–CB), Koekemoer 480 (PRE).

Sectio 3. *Uniflos Koekemoer*, sect. nov., capitula homogama, uniflora; flores radii femineae; flores disci hermaphroditi; flores radii et disci: rosei vel albi; cypselae florum et radii et disci fertiles. Sectio vulgaris. Typus sectionis: *D. tortilis* (DC.) Sch. Bip.

Capitula homogamous, 1-flowered; ray flowers female; tubular flowers hermaphrodite; colour of ray and tubular flowers similar: either pink or white; cypselas fertile in ray as well as tubular flowers. A widespread section.

The name *Uniflos* refers to the one-flowered heads of the species in this section.

5. *Disparago tortilis* (DC.) Sch. Bip. in Jahresbericht der Pollichia: 25(181) (1861). Type: C.B.S., Uitenhage, Ecklon 1576 (G-DC, lecto., here designated; microfiche PRE!).

Stoebe tortilis DC. 260 (1837).

D. ericoides auct. non Berg. nec Gaertn.: 463 (1791); Cass.: 348 (1825); DC.: 257 (1837); Harv.: 278 (1894); Levyns: 100 (1936a); R.A. Dyer: t. 1102 (1951).

The name *D. tortilis* has not been used extensively in the history of the genus. This taxon was widely known under a misapplied name, *D. ericoides*. Although the type specimen of *D. tortilis* is very poor, there is no doubt about its identity or about the identity of *D. ericoides*.

Shrubs up to 1 m tall, profusely branched, erect or bushy. *Leaves* filiform, 4–8(–10) × 0.5–0.8 mm, spirally twisted with 1–1½ twists, usually spreading, sometimes appressed, margins tightly involute, apex mucronate. *Synflorescence* usually with numerous, sometimes only about 5 heads, in usually globose aggregations, or if tubular then often interrupted at base. *Heads* 1-flowered, with either tubular or ray flower. *Involucre* of 6–8 bracts, in 2 series, narrowly cymbiform, in outermost series often chaffy in lower half and foliaceous in upper half. *Ray flowers* female, usually pink (various shades), occasionally white, 2.7–3.3 × 2.5–3.0 mm; cypselas fertile, surface puberulous, apical annulus often well developed. *Tubular flowers* hermaphrodite, usually pink, or white, glands sometimes

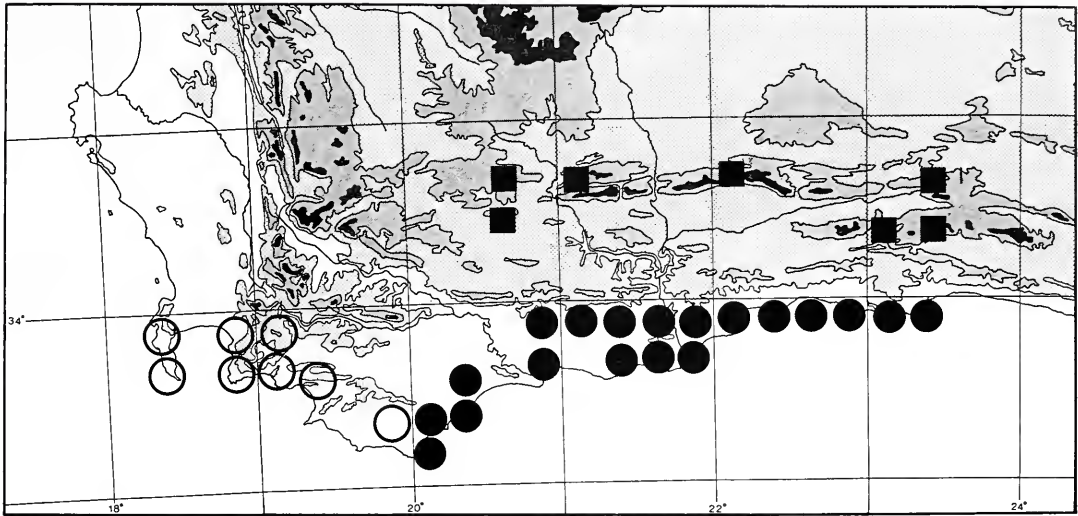


FIGURE 2.—Geographical distribution of *D. kolbei*, ■, *D. kraussii*, ●, and *D. laxifolia*, ○.

present on outside of lobes; cypselas fertile and identical to those of ray flowers. *Pappus* usually of 5 plumose hairs, not connate, occasionally up to 20 hairs in robust forms and then slightly connate at base.

Distribution of this species is disjunct: it is found from Jonkershoek and Simon's Bay along the south and east coasts (not more than 150 km inland) to the Dweza State Forest in Transkei and re-appears around Port Edward and Port Shepstone, where it occurs in what appear to be relict fynbos areas (Figure 3). *D. tortilis* is very well adapted to the grassy fynbos of the eastern Cape and is a pioneer in disturbed areas.

Specimens examined

NATAL.—3030 (Port Shepstone): Murchison, (—AA), *Medley Wood* 3078 (NH); Oribi Gorge, (—CA), *Mc Clean* 578 (PRE, NH); *Van Wyk* 5415 (PRE); top of Horseman's Point, (—CB), *Glen* 473 (STE); Oribi Nature Reserve, footpath between Lukonka Point and Umfezi Point, (—CB), *Abbott* 1879 (NH); Fourman's Hill, (—CB), *Koekemoer* 264 (PRE); Umtamvuna Nature Reserve, Iron Crown, (—CC); *Abbott* 1929 (NH); *Koekemoer* 261 (PRE); Uvongo River tributary, Wichman's Farm, (—CD), *Nicholson* 1704 (PRE); Port Shepstone Sea Park, (—CD), *Strey* 8116 (PRE); Umzumbi, (—DA), *Medley Wood* 12857 (PRE). **3130** (Port Edward): Port Edward, (—AA), *Acoks* 10910 (PRE).

CAPE.—3227 (Stutterheim): Dohne Research Station, (—CB), *Perks s.n.* (GRA A1370); Mount Coke, (—CD), *Sim* 1418 (GRA, NBG); East London, Bonza Bay, (—DD), *Acoks* 9552 (PRE). **3228** (Butterworth): Dwesa, (—BD), *Abbott* 2633 (NH); East London, Kei Mouth, (—CB), *Flanagan* 213 (BOL, GRA, NBG, SAM); Stutterheim, Kentani, (—CB), *Pegler* 260 (BOL, NBG); East London, Gonubi Springs, (—CC), *Acoks* 10986 (PRE); Kentani River mouth, (—CC), *Galpin* 5789 (PRE); Gonubi Springs, (—CC), *Compton* 17043 (NBG); *Levyns* 10826 (BOL). **3318** (Cape Town): Jonkershoek, (—DD), *Kruger* KR339 (PRE). **3319** (Worcester): Jonaskop, (—DC), *Boucher* 5012 (PRE). **3320** (Montagu): Witteberg, (—BC), *Humbert* 9804 (PRE); Marloth Nature Reserve, (—CD), *Taylor* 7686 (PRE). **3321** (Ladismith): Garcia's Pass, (—CC), *Leipoldt* 16049 (BOL); Fouriesberg, (—DD), *Koekemoer* 475 (PRE). **3322** (Oudtshoorn): Swartberg, (—AC), *Pienaar* 41 (STE); Spitskop, (—AD), *Koekemoer* 331 (PRE); Meiringspoort, (—BC), *Esterhuysen* 24855 (PRE); Swartberg east, Magas, (—BC), *Marshall* 253 (PRE); Klein Moeras River, (—CC), *Koekemoer* 473 (PRE); Robinson Pass, (—CC), *Koekemoer* 476 (PRE); Waboomskraal, (—CD), *Lewis* 68721 (BOL); Kamanassie Mountains, Laudina, (—DB), *Esterhuysen* 18337 (BOL, PRE); Mannetjies Mountain, (—DB), *Esterhuysen* 6404 (BOL); *Taylor* 1469 (SAAS). **3323**

(Willowmore): Slopsteen Mountain, (—AC), *Esterhuysen* 6305 (BOL, PRE), 6316 (PRE); Antonies Mountain, (—AD), *Esterhuysen* 24965 (BOL); Potjies River Height, (—CA), *Hugo* 1473 (PRE, STE); *Thompson* 964, 1335 (PRE, STE); Hill NE of Avontuur, (—CA), *Fourcade* 4607 (BOL); *Koekemoer* 485 (PRE); Langkloof, near Ongelegen siding on road to Kareedouw, (—CB), *Immelman* 324 (PRE, STE); Hoopsberg, (—CB); *Esterhuysen* 6579 (BOL); *Koekemoer* 479 (PRE); Kouga Mountains, Farm Hoeree, (—DB), *Oelofsen* 43 (PRE); Tuschen Bij, Tsitsikama, (—DD), *Fourcade* 487 (STE); 7 miles east of Joubertina, (—DD), *Ward* 5697 (PRE); The Hoek, valley at foot of Outeniqua Mountains, (—DD), *Esterhuysen* 10606 (BOL); Joubertina, (—DD), *Esterhuysen s.n.* (BOL48263). **3324** (Steytlerville): Baviaanskloof Mountains, between Smitkraal and Wilgerhof, (—CB), *Thompson* 1945 (PRE, STE); between Patensie and Willowmore, (—CB), *Koekemoer* 281 (PRE); Kareedouw Pass, (—CC/CD), *Fourcade* S.D. (STE); Assegaai Bosch road to Kareedouw, (—CD), *Britten* 1247 (PRE); Assegaibosch, (—CD), *Breyer* 23313 (PRE); *Levyns* 5589 (BOL); Kareedouw Pass, (—CD), *Gillett* 1499 (STE); *Koekemoer* 324 (PRE); Farm Goedeheop, (—DA), *Stirton* 9593 (PRE). **3325** (Port Elizabeth): Rietberg, above Kirkwood, (—AD), *Nordenstam* 282 (S); Somerset Oos, Kommdagga, (—BB), *Bayliss* BS-1589 (PRE); Zuurberg, above Slagboom, (—BC), *J.R. & B.R.* 452 (BOL, GRA); Zuurberg National Park, Brandrug, (—BC), *Koekemoer* 64, 169 (PRE); Addo Elephant Park, Zuurkop, (—BD), *Archibald* 3867 (PRE); Ferniebrae, (—BD), *Koekemoer* 63 (PRE); Zuurberg Inn, (—BD), *Koekemoer* 170 (PRE); Addo Elephant Park, Zuurkop, (—BD), *Barnard* 575 (PRE); Zuurberg Pass, (—BD), *Nordenstam* 355, 367 (S); Groendal Wilderness Catchment area, (—CA), *Scharf* 1172, 1455, 1608 (PRE); Port Elizabeth, 1 mile west of Rocklands, (—CA), *Wisura* 2858 (NBG); Port Elizabeth, (—CB), *Cruden* 441 (GRA); Couga Mtns, (—CB), *Taylor* 899 (NBG); Van Stadens Reserve, (—CC), *Dahlstrand* 1977, 2538 (STE), 3209, 3220 (PRE); *Mkhoyana* 20 (GRA); 18 km from Port Elizabeth on road to Van Stadens Pass, (—CC), *Koekemoer* 61 (PRE); Witteklip, (—CC), *Rodin* 1011 (P, PRE); near Port Elizabeth, (—DC), *Tyson* 2179 (PRE, SAM, STE); flats near Van Stadens River Mtn, (—CC), *Ecklon & Zeyher s.n.* (GRA); Blue Mtn, Loerie, (—CC), *Dix* 7 (GRA); Van Stadens Mtn, (—CC), *Ecklon & Zeyher* 51 (5.2) (SAM), 166 (4.2) (S); *Zeyher* 712 (NBG); Bethelsdorp, (—CD), *Bolus s.n.* (NBG, PRE); Van Stadens River, (—CD), *Koekemoer* 323 (PRE); Port Elizabeth, Springs Nature Reserve, (—CD), *Olivier* 2517 (GRA, PRE); Ten Top Hill, Groendal, (—CD), *Olivier* 3193 (PRE); Uitenhage, (—CD), *Pappe s.n.* (GRA); near 'Thees', Van Stadens River, (—CD), *Scott Elliot* 295 (NBG); Theescomb, (—CD), *Bolus s.n.* (BOL); Van Stadens Reserve, (—CD), *Pienaar* 57 (GRA); 14 km NW of Rocklands on Elands River rd, (—CD), *Smijman* 325 (NBG PRE); flats between Krakakamma and Van Stadens Mtn, (—CD), *Ecklon & Zeyher* 99 (5.2) (S); Uitenhage, (—CD), *Pappe s.n.* (GRA); Addo National Park, Zuurkop, (—DA), *Archibald* 3867 (BOL); *Botha* 5677 (GRA); 2 miles SW of Addo Drift, (—DB), *Fries, Norlindh & Weimarck* 761, 1175 (BOL); Alexandria, 6.5 miles N of Nanaga shop, (—DB), *Acoks & Story* 2795 (PRE); near Port Elizabeth golf course, (—DC), *Britten* 1789 (GRA); 8 miles from Port Elizabeth to Grahamstown, (—DC), *Comins* 751 (PRE); Markman Industrial Area, Port Elizabeth, (—DC), *Dahlstrand* 2835

(GRA, PRE, STE); Coega, (–DC), *Horn D.H.S.* (PRE); 26 km from Port Elizabeth on N2 to Grahamstown, (–DC), *Koekemoer* 278, 279 (PRE); 24 km from Port Elizabeth, (–DC), *Koekemoer* 280 (PRE); Parsons Vlei, (–DC), *Long* 36 (GRA); Redhouse, (–DC), *Long* 1062 (GRA); Koega, Farm Sonop, (–DC), *Olivier* 708 (NBG), 1582 (PRE); Redhouse, (–DC), *Paterson* 478 (GRA); between Port Elizabeth and Grahamstown, (–DC), *Story* 2821 (PRE); Port Elizabeth, Kabega Park, (–DC), *Olivier* 440 (GRA); Port Elizabeth golf course, (–DC), *Walters P(1)* (NBG); Port Elizabeth, (–DC), *West* 167 (GRA); Walmer, (–DC), *Ecklon s.n.* (BOL48256, STE); *Paterson* 1174 (BOL); Port Elizabeth, (–DC), *Drège* 149 (PRE); Algoa Bay, (–DD), *Zeyher* 2921 (P, S, SAM, STE). **3326** (Grahamstown): Alicedale, (–AC), *Bayliss BR-404* (PRE); Hofman's Bosch, (–AC), *Britten* 1016, 1137 (GRA); Alexandria, Hillary, (–AC), *Burt Davy* 14245 (BOL); Tsitsikama National Park, (–AC), *Retief* 396 (PRE); Highlands road, Farm Atherstone, (–AD), *Boucher* 2484 (PRE, STE); Highlands road, near railway crossing, (–AD), *Brink* 213 (GRA, PRE, STE); Alicedale road near Grahamstown, (–AD), *Brink* 378 (GRA, PRE); Howieson's Poort, (–AD), *Batten s.n.* (NBG); *Comins* 1701 (GRA, NBG, STE), 1707 (GRA); *Rennie* 327 (BOL); Grahamstown, (–AD), *Guthrie* 3310 (NBG); Coldspring, (–AD), *Jacot Guillarmod* 8720 (PRE), 9569 (GRA, PRE); Highlands station, (–AD), *Burt Davy* 7951 (BOL, PRE); near Coldstream station, (–AD), *Killick* 776 (PRE); between Grahamstown and Alexandria, 1 km from Salem, (–AD), *Koekemoer* 174 (PRE); Atherstone, (–AD), *Koekemoer* 277 (PRE); Grahamstown, Frasers Reserve, (–AD), *Shumane P28* (GRA); Salem, (–AD), *Zeyher* 291 (S, SAM); Albany, (–BC), *Erens PRE28359* (PRE); 5 km from Grahamstown on road to Port Alfred, (–BC), *Germishuizen* 1511 (PRE); on R67, 13 km from Grahamstown near Belmont Valley, (–BC), *Koekemoer* 272 (PRE); Grahamstown near Settlers Monument, (–BC), *Koekemoer* 273 (PRE); Gunfire Hill, (–BC), *Richardson* 21, 27 (GRA); Grahamstown, (–BC), *Britten* 1939-11 (NBG); *Dyer* 153 (GRA); *MacOwan* 1002 (BOL); *Marloth* 6130 (PRE); *Rogers* 27267 (GRA), 27367 (BOL, STE); *Theron* 496 (PRE); *Tyson* 16837 (BOL); Signal Hill (–BC), *Levyns* 3765 (BOL); Grahamstown hills, (–BC), *Tyson* 16837 (SAM); Port Elizabeth, Vaal Vlei Estate, (–BC), *Mogg* 4702 (PRE); Bathurst, 8.7 miles WNW of Kleinemonde, (–BD), *Acocis* 21820 (BOL, PRE); Round Hill, (–BD), *Bolus* 4110 (PRE); Bathurst, Farm Hopewell, (–BD), *Compton* 19839 (NBG); Grahamstown, (–CA), *Britten* 6559 (PRE); Alexandria Dist., (–CB), *De Vos c-18446* (STE); Alexandria, near station, (–CB), *Galpin* 10634 (PRE); Alexandria, Nauaga, (–CB), *Bond* 1241 (NBG); Alexandria, NE of Nananga Post Office, (–CB), *Acocis* 12795 (PRE); Alexandria, (–CB), *Archibald* 4381 (GRA); Grahamstown, Barville Park near Kasouga, (–DA), *Bayliss* 8582 (GRA); 8 km from Port Alfred at Hayes siding,

(–DB), *Retief* 299 (PRE); Kowie West, (–DB), *Tyson s.n.* (BOL13299, PRE); betw. Grahamstown and Coegha, (–DC), *Sidey* 1678 (PRE). **3327** (Grahamstown): near Bell, Dist. Peddie, (–AB), *Galpin* 7688 (GRA); Grahamstown, near war monument at Kaffir drift Police Sta., (–AC), *Burrows* 2776 (GRA); East London, above Kwani River, (–BA), *Comins* 1519 (PRE); East London, The Springs, (–BA), *Rattray* 1370 (BOL). **3418** (Cape Town): Noordhoek Peak, (–AB), *Gillett* 3568 (PRE); above Chapmans Peak Drive, (–AB), *Whellan* 1786 (PRE); Palmiet River Mouth, (–BD), *Boucher* 1045 (PRE). **3419** (Caledon): Lebanon Reserve, Grabouw, (–AA), *Verdoucq* 87 (STE); Hermanus, Fernkloof, (–AD), *Orchard* 321 (PRE); Zwarteberg and Klein Rivers Mountain, (–AD), *Ecklon s.n.* (S); 2 miles W of Papiesvlei Post Office, (–BC), *Acocis* 22312 (PRE); Paardeberg Mountain, (–BC), *Stokoe* 64076 (PRE); The Kelders (–CB), *Van der Merwe* 2033 (PRE). **3420** (Swellendam): Bontebok Park, (–AB), *Liebenberg* 6751 (PRE, STE), 7179 (PRE); De Hoop, Oulande, (–AD), *Fellingham* 874 (PRE); *Van Wyk* 2179 (PRE); Potberg, (–BC), *Acocis* 23011 (PRE); Bredasdorp, Die Poort, (–CA), *Compton* 22609 (STE). **3421** (Riversdale): Langeberg, above Herbetsdale, (–BB), *Muir* 1259 (BOL); Skulpiesbaai, (–BC), *Van Schalkwyk* 84 (PRE). **3422** (Mossel Bay): Goukamma Nature Reserve, (–BB), *Heinecken* 217 (PRE). **3423** (Knysna): The Heads, (–BB), *Phillips* 1050 (SAAS); Tsitsikama Coastal Park, (–BB), *Retief* 396 (PRE); Plettenberg Bay, (–AB), *Rogers* 22690 (PRE); Ratels Bosch, Tsitsikama, (–BB), *Fourcade* 336 (BOL, GRA). **3424** (Humansdorp): E of Witelsbos, (–AA), *Hutchinson* 1418 (K); Humansdorp, (–BB), *Burt Davy* 11984 (PRE); *Levyns* 3788 (BOL); *Rogers* 2946 (PRE); Cape St Francis, (–BB), *Thompson* 896 (PRE, STE); Kareedouw Pass, (–BB), *Gillett* 1373 (STE), 2023 (K); Humansdorp, Majo, (–BB), *Ecklon & Zeyher* 51 (4.2) (SAM); Port Elizabeth, Winterhoek Mtn, (–DC), *Fries, Norlindeh & Weimarck* 1082 (BOL, S); Redhouse, (–DC), *Fries, Norlindeh & Weimarck* 545 (BOL); Port Elizabeth, (–DC), *Fries, Norlindeh & Weimarck* 21 (BOL). **3425** (Port Elizabeth): Cape Recief, (–BA), *Ecklon & Zeyher* 113 (93.7) (S).

Section 4. Disparago

Capitula heterogamous, 2-flowered; ray flowers sterile; tubular flowers hermaphrodite, colour of ray and tubular flowers similar: either white or pink; cypselas reduced in ray flowers, fertile in tubular flowers. Confined to coastal flats.

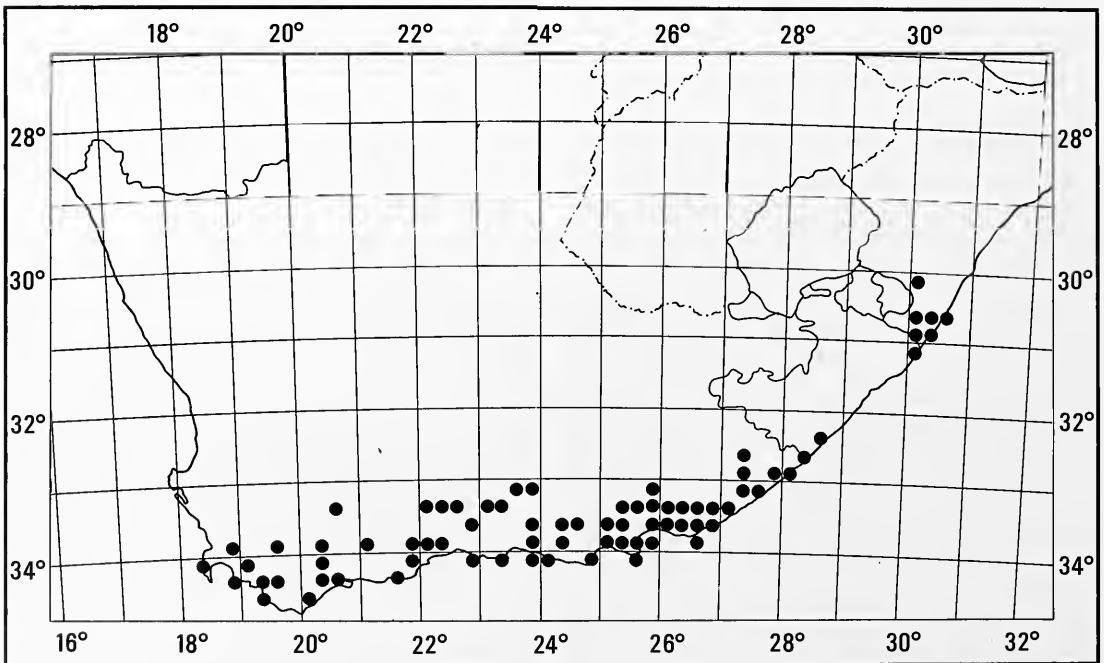


FIGURE 3.—Geographical distribution of *D. tortilis*.

6. *Disparago anomala* Schltr. ex Levyns in Journal of South African Botany 2: 101 (1936a). Type: Cape, Worcester, Papiessvlei, *Schlechter 10443* (PRE, lecto.!, here designated; G(2x)!, GRA!; PRE(4x)!, S!).

D. anomala Schltr. in sched.

D. anomala Schltr. ex Bolus & Wolley-Dod: 280 (1904), nom. nud.

The specific name refers to the absence of a pappus.

Shrublets very variable, 80–150 or 300–800 mm tall, profusely and densely branched and cushion-like or large open shrubs. *Leaves* filiform, 3–7(–10) × 0.4–0.6 mm, spirally twisted with 1–1½ twists, mucronate, mucro unobtrusive or to 0.8 mm long, margins fully involute. *Synflorescence*: heads in globose or subglobose aggregations. *Heads* 2-flowered or sometimes 1-flowered, usually 1 ray flower and 1 tubular flower. *Involucre* in 2 series, inner series of 3 or 4 bracts, chaffy, 3–5 × 0.4–0.7 mm, usually bicoloured, outer series often only partly chaffy. *Ray flowers* sterile, 1.7–2.0 × 1.3–1.6 mm, usually white or sometimes pink; cypselas reduced, often not distinct from corolla. *Tubular flowers* hermaphrodite, ?lobes apparently not opening in star-like manner; cypselas pentagonal, apical annulus usually well developed, surface puberulous, hairs falcate. *Pappus* absent.

Distribution: *D. anomala* occurs on coastal flats in the southwestern Cape. It is very common in the Peninsula and spreads northwards to Blackheath and eastwards to the Breede River (Figure 4). It very often grows on calcrete ridges or calcareous soils.

Specimens examined

CAPE.—3318 (Cape Town): Blackheath, (–DC), *Boucher 5083* (STE); *Raitt 44* (STE, PRE). 3418 (Simonstown): Peninsula, Witsand, (–AB), *Penfold 228* (NBG); Boon Mountain, (–AB), *Pillans 4919* (BOL); *Salter 4277* (K); Klipfontein road, E of Mowbray, (–AB), *Salter 280-15* (BOL); Buffels Bay, (–AB), *Salter 280-15b* (BOL); Rheboks Dam, Good Hope Nature Reserve, (–AB), *Taylor 6732* (PRE); Sirkelsvlei, (–AD), *Compton 19371* (NBG, STE); Bonteberg, (–AD), *Compton 10627* (NBG); Buffels Bay, (–AD), *Compton 13000* (NBG); Brightwater, (–AD), *Compton 14571* (NBG); slope above Smitswinkel Bay, (–AD), *Esterhuysen 32819* (BOL); *Galpin 12785* (PRE); *Gillett 1508* (K); Cape Point, (–AD), *Gillett 3474* (STE); Good Hope Nature Reserve, (–AD), *Koekemoer 354* (PRE); Smitswinkel Bay, (–AD), *Levyns 4935* (BOL); *Salter 4281* (PRE, K); Buffels Bay, (–AD), *Salter 2933, s.n.* (BOL); Good Hope Nature Reserve, near Gifkommetjie turnoff, (–AD), *Taylor 6717a* (STE); Smitswinkel Vlei, (–AD), *Wolley-Dod 766* (K); Cape Flats, (–BA), *Adamson 4256* (BOL); Cape Flats near beacon FO-ST2, (–BA), *Taylor 3150* (PRE, STE); near Faure, (–BB), *Galpin 12565* (PRE); W of Faure, (–BB), *Salter 4326* (PRE, BOL, K); Die Punt, Pringle Bay, (–BD), *Boucher 1461* (STE, PRE); Caledon, Hanglip, (–BD), *Esterhuysen 33494* (BOL); Betty's Bay, (–BD), *Levyns 10072* (BOL); Pringle Bay, (–BD), *Levyns 10847* (BOL); Rooiels, (–BD), *Parker 4180* (BOL, NBG). 3419 (Worcester): Houwhoek, (–AA), *Bolus s.n.* (PRE); *Guthrie 3601* (NBG); *Schlechter 7412* (BOL, G, P); S of Caledon, (–AB), *Salter 9034* (SAM); Hawston, (–AC), *Leighton 410* (BOL); Onrust River, (–AC), *Schlechter 19035* (STE); *10393* (BOL, G, GRA, PRE, S); border between Wortelgat and Walker Bay State Forest, (–AD), *Bösenberg & Rutherford 226* (STE); near Shaw's Mtn, (–AD), *Salter 9034* (BOL); Papiessvlei, (–AD/BC), *Schlechter 10443* (G, GRA, PRE); Genadendal, (–BA), *Gillett 899* (STE); Flouhoogte, E of Stanford, (–BC), *Hugo 1544* (PRE, STE); Die Skeiding, between Bredasdorp and Elim, (–BC/BD), *Fellingham 249* (PRE, STE); Bredasdorp Mountain, (–BD/DB), *Galpin 10479* (G, PRE); Gans Bay, (–CB), *Hall 4610* (NBG, PRE); Die Kelders, (–CB), *Koekemoer 347* (PRE); Hagelkraal, (–DA), *Barker 5276* (NBG); *Compton 19035* (STE); *Hugo 1591* (STE), *1721* (PRE, STE); *Lewis 63089* (SAM); Viljoenshof between Elim and Die Dam, (–DA), *Koekemoer 348* (PRE); *Van Wyk 799* (STE); Groot Hagelkraal, near Pearly Beach, (–DA), *Van Wyk 1146* (PRE, STE); Elim, (–DB), *Barker 5288* (NBG); *Schlechter*

7679 (BOL, G, GRA); Die Poort, between Bredasdorp and Elim, (–DB), *Bolus 20538* (BOL); between Bredasdorp and Elim, (–DB), *Gillett 1444* (STE); flats between Bredasdorp and Elim, (–DB), *Levyns 4871* (PRE, BOL); Bredasdorp Forest Reserve, (–DC), *Hugo 1643* (PRE, STE); 2 km from Elim, (–DC), *Koekemoer 346* (PRE). 3420 (Bredasdorp): Bontebok Park, (–AB), *Compton 21929, 22630* (NBG); De Hoop, Potberg, (–BC), *Burgers 1759* (PRE, STE), *1815* (PRE); Potberg, Farm Albertsdale, (–BC), *Compton 19531* (NBG); Potberg, (–BC), *Koekemoer 182, 183* (PRE); *Levyns 8180, 11554* (BOL); *Lewis 63082* (SAM); *Thompson 3766* (PRE, STE); Bredasdorp, Die Poort, (–CA), *Compton 22609* (NBG); Bredasdorp, (–CA), *Levyns 3523* (BOL); between Bredasdorp and Struis Bay, (–CA), *Levyns 3534a* (BOL); Bredasdorp, (–CA), *Levyns 11547* (BOL); Bredasdorp, Heuningberg Nature Reserve, (–CA), *Koekemoer 184* (PRE); Bredasdorp, 1 km from Struis Bay to Elim, (–CC), *Koekemoer 343* (PRE).

7. *Disparago ericoides* (Berg.) Gaertn., *Fructibus et seminibus plantarum* 2: 463 (1791); Less.: 363 (1832). Type: 'e Cap. b. Spei', *Thunberg s.n.* (SBT; photocopy and fragment in PRE!).

Stoebe ericoides Berg.: 339 (1767); Thunb.: 169 (1800); Thunb.: 726 (1823); Spreng.: 442 (1826). *Seriphium ericoides* (Berg.) Pers.: 500 (1807).

Stoebe torta Spreng.: 442 (1826). Type not seen.

D. lasiocarpa Cass.: 42 (1825); DC.: 258 (1837); Harv.: 278 (1894); Levyns: 102 (1936a), *synon. nov.* Type not seen.

Wigandia disparaginoides Less.: 362 (1832). Type not seen.

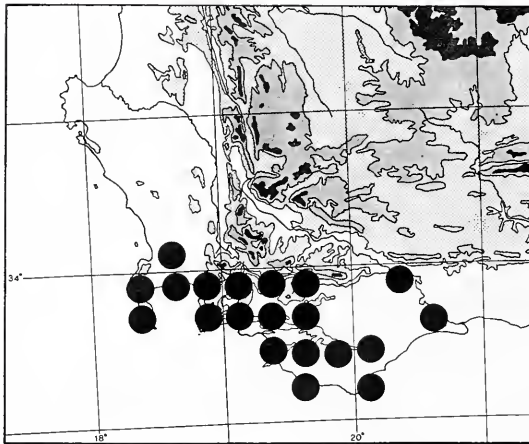
D. seriphoides DC.: 257 (1837). Type: Burchell 705, not seen.

D. hoffmanniana Schltr.: 203 (1900). Type: in regio austro-occidentalis, in ditione Caledon, alt. c. 1500 ped., 21 December 1896, *Schlechter 9801* (PRE, lecto.!, here designated; BOL!, GRA!).

Because of the nature and uniqueness of the cypselas of this species it is very easy to identify, even from a description. A fragment of the type specimen in the Bergius Herbarium and a drawing by Mr Lars Kers confirmed that this name was misapplied to *D. tortilis* for many years.

Small compact or larger open shrubs, 100–300(–800) mm tall, profusely branched. *Leaves* filiform, 2–8 × 0.3–0.6 mm, spirally twisted with 1–1½ twists, usually spreading but often appressed especially near inflorescence, mucronate, margins involute with margins touching. *Synflorescences* variable in robustness, number of heads and degree of aggregation. *Heads* with 1 ray and 1 tubular flower; flowers strongly honey-scented. *Involucre* of 4–6 bracts, in 2 series; bracts in inner series narrowly cymbiform, acute, yellowish with reddish tinge near apex; outer series protected by 4–6 spatulate, foliaceous bracts. *Ray flowers* sterile, ray 2.5–3.5(–4.0) × 1.5–2.0 mm, in shades of pink, or white; cypselas reduced. *Tubular flowers* hermaphrodite; cypselas woolly, apical annulus a loose arrangement of hairs. *Pappus* of 15–20 plumose hairs, connate at base.

Distribution: from Cape Point northwards to Malmesbury, De Doorns and Montagu and eastwards to Potberg. It was also collected at Ystervark Point and Plettenberg Bay. The distribution is disjunct with gaps between Heidelberg and Riversdale and between Mossel Bay and Knysna (Figure 5).

FIGURE 4.—Geographical distribution of *D. anomala*.

Specimens examined

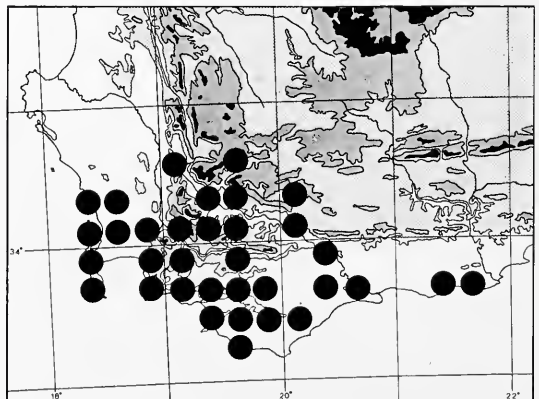
CAPE.—3318 (Cape Town): Springfontein, (–CB), Axelson 376 (NBG); Bokke River, (–CB), Hugo 974 (PRE, STE); near Melkbosch, (–CB), Wasserlau 775 (NBG); Kenilworth, (–CD), Bolus 3297 (PRE); Flanagan 2448 (PRE); top of Table Mountain, (–CD), Schonberg 4888 (PRE); S of Koeberg, (–CD), Pillans 6793 (BOL), s.n. (GRA); Farm Burgers Post, near Pella, (–DA), Boucher & Shepherd 4923 (PRE, STE); Koeberg, (–DA), Goldblatt 5313 (PRE); between Cape Town and Malmesbury, (–DA), Montgomery 382 (STE); Kraaifontein, (–DC), Low 794 (STE); Stellenbosch, (–DD), Drège s.n. (PRE-12826). 3319 (Worcester): Waterval, Tulbagh, (–AC), Drège s.n. (GRA); De Doorns, Groot Kloof, (–BC), Stokoe 63085 (PRE); Matroosberg, N slope, (–BC), Esterhuysen 18713 (BOL); between Worcester and Rawsonville, (–CB), Esterhuysen 19677 (PRE, NBG); near Edelweiss garage, Breede River, (–CB), Walters 2394 (SAAS); Franschhoek, Zachariashoek Catchment, (–CC), Kruger 887 (STE); La Motte Forest Station, Zachariashoek, (–CC), Viviers 104 (STE); Franschhoek Pass, (–CC), Compton 12966 (NBG); Franschhoek Pass, near Catspad memorial needle, (–CC), Koekemoer 352 (PRE); Audensberg, (–CD), Esterhuysen 28185 (BOL, PRE); Blaaskloof, W slope of Keeromsberg, (–DA), Esterhuysen 27583 (?BOL); Jonaskop, (–DC), Boucher 4244 (STE). 3320 (Montagu): Pypsteelfontein, Waboomsberg, (–CA), Moffett & Steensma 4118 (STE); between Swellendam and Barrydale, (–CC), Marsh 1135 (PRE, STE). 3418 (Cape Town): near Muizenberg, (–AB), Bolus 3297 (GRA); Peninsula, near Kommetjie, (–AB), Galpin 12783 (PRE); Noordhoek Mountain, (–AB), Gillett 3568 (STE); Simonstown, top of Redhill near Pinehaven, (–AB), Koekemoer 353 (PRE); S slopes of Chapman's Peak, (–AB), Pillans 3027 (PRE); Simonstown, Farm Bergvliet, (–AB), Purchell 90475 (BOL); Good Hope Nature Reserve, Olifantbos road near Klein Rondevlei, (–AB), Taylor 7632 (PRE, STE); Good Hope Nature Reserve, (–AB), Rodin 3304 (PRE); Kommetjie, (–AB), Penfold 237 (BOL); Smitswinkel, (–AD), Galpin 12782 (PRE); Red Hill, (–AD), Taylor 5686 (PRE, STE); near Platboom Street, Southern hills, Plot 33, (–AD), Taylor 6652 (PRE, STE); Helderberg, (–BB), Galpin 12308 (PRE); Palmiet River Mouth, (–BB), Levyns 5357 (BOL); Steenbras Valley, (–BB), Stokoe 2568 (PRE); Cape Flats, (–BC), Ecklon 1841 (S); near Palmiet River Mouth, (–BD), Boucher 1045 (STE); Betty's Bay, (–BD), Boucher 1446 (PRE, STE); Kogelberg, (–BD), Boucher 1780 (PRE, STE); Hangklip, (–BD), Compton 6071 (NBG); Rooiels, (–BD), Koekemoer 351 (PRE); Palmiet River Valley, (–BD), Stokoe 8718 (PRE); Palmiet River, (–BD), Stokoe 58132 (PRE, BOL); Kogelberg Reserve, (–BD), Van Wilgen 108 (PRE, STE). 3419 (Caledon): Viljoen's Pass, (–AA), Rodin 3099 (PRE); top of Viljoen's Pass, (–AA), Stokoe 65913 (PRE); Caledon (–AB), Bolus 9172 (PRE); Hermanus, (–AC), Compton 23223 (NBG); Kleinmond, (–AC), De Vos 541 (STE); Onrust River Mountain, (–AC), Esterhuysen 4916 (NBG, PRE); Botrivier, Kleinmond, (–AC), Taylor 3785 (NBG); Tulbach waterfall, (–AC), Ecklon 51 (1.11) (SAM-38472); Hermanus golf course, (–AC), Walters 55 (PRE); Onrust River, (–AD), Compton 4916 (NBG); Hermanus, (–AD), De Beer 23224 (PRE); Babylons Tower, (–AD), Esterhuysen 1941 (BOL); Hermanus, flats near Klein River, (–AD), Galpin 12764 (PRE); Shaw's Mountain Pass, (–AD), Hafström & Acocks 2251 (PRE); Femkloof Nature Reserve, (–AD), Orchard 537 (PRE, STE); 1 km from Caledon on Shaw's Pass, (–AD), Stirton 11103 (STE); Klein

River Mountain, (–AD), Stokoe 68737 (BOL, PRE); Genadendal, near mission station, (–BA), Levyns 4847 (PRE); Genadendal Mountains, (–BA), Schlechter 9801 (BOL, GRA, PRE); Zondagskloof, (–BC), Compton 10228 (NBG); Hartbees River, (–BC), Elbrecht 22151 (PRE); Bredasdorp, (–BD), Barker 7259 (GRA, NBG); Paardenberg, (–BD), Jordaan c18458 (STE); The Kelders, (–CB), Van der Merwe 2033 (STE); Danger Point, (–CB), Leighton 1560 (PRE); Danger Point, (–CB), Compton 10262 (NBG); Baardscheedersbosch, (–DA), Compton 20454 (NBG); Elim, (–DA), Drake 9643; Schlechter 3515, 9643 (PRE); Blaaskloof, Keeromsberg, (–DA), Esterhuysen 27583 (PRE); 1 km from Viljoenshof between Elim and Die Dam, (–DA), Koekemoer 349 (PRE); Ratel River, (–DA), Lewis 5250 (NBG); Hagel Kraal, (–DA), Lewis 63088 (BOL); between Pearly Beach and Viljoenshof, (–DA), Simpson 213 (STE); Uintjieskuil, (–DB), Van Breda & Admiraal 2353 (PRE); 3 km from Die Dam to Elim, (–DC), Koekemoer 344 (PRE). 3420 (Riversdale): Bontebok National Park, (–AB), Grobler 592 (PRE, STE); Koekemoer 308, 339 (PRE); Liebenberg 7970 (PRE); De Hoop, (–AD), Van der Merwe 1362 (PRE, STE); Potberg, above Diepkloof, (–BC), Burgers 1640b (STE); Potberg, (–BC), Taylor 4337 (PRE); Bredasdorp, (–CA), Hafström & Acocks 2250 (PRE). 3421 (Riversdale): Still Bay, (–AD), Muir 439 (PRE); Ystervarkpunt, Kampong entrance, N block, (–BC), Willems 109 (STE).

8. *Disparago kraussii* Sch. Bip. in Flora 2: 693 (1844); Harv.: 278 (1894); Levyns: 100 (1936a). Type: Cape Province, near Tsitsikama, *Krauss s.n.* (P-CO, specimen on the far left, lecto.!, here designated).

The type, *Krauss s.n.*, is mounted with two other specimens on the same sheet in the Cosson Herbarium. The specimen of Drège in the centre is *D. laxifolia*, whereas the two others are of *D. kraussii*. The specimen on the left is chosen as lectotype because the original label of Krauss is mounted with it. All three specimens are provided with notes in Schultz Bipontinus's handwriting.

Small shrublets, often profusely branched and dwarfed, 150–500(–800) mm tall. *Leaves* linear, 4–8 × 0.3–0.5 mm, spirally twisted, appressed or slightly spreading, margins involute and almost touching, mucronate at apex. *Synflorescence* globular or ovate aggregation of heads. *Heads* with 1 ray and 1 tubular flower. *Involucre* of about 6 bracts in 1 or 2 series; narrowly cymbiform, smooth, yellowish. *Ray flowers* sterile, ray 1.8–2.2 × 0.7–1.5 mm, usually white or sometimes pink; cypselas reduced. *Tubular flowers* hermaphrodite; cypselas puberulous, hairs falcate, more prominent on ribs, apical annulus well developed. *Pappus* present in tubular flowers, of (3–)5(–8) plumose hairs, not coalescent; occasionally poorly devel-

FIGURE 5.—Geographical distribution of *D. ericoides*.

oped and then only 1 or 2 hairs per flower and lacking in some heads.

In *Taylor 7720* a pappus, identical to that in the tubular flowers, was present in the sterile ray flowers, whereas in *Compton 23519*, reduced stamens were present in the sterile ray flowers.

Distribution: *D. kraussii* can be found along the southern coast of the Cape from De Hoop Nature Reserve to Still Bay (Figure 2).

Specimens examined

CAPE.—**3420** (Riversdale): De Hoop, (–AD), *Barker 8743* (NBG); *Burgers 162* (PRE, STE); *Van der Merwe 1181* (PRE); Die Poort, Bredasdorp, (–AD), *Compton 22609* (STE); De Hoop game camp, (–AD), *Van der Merwe 1112* (PRE); De Hoop, calcareous ridges, (–AD), *Barker 8693* (NBG); Heidelberg, Witsand, (–BB), *Levyns 10729* (BOL); De Hoop, Farm Hamerkop, (–BC), *Van Wyk 1605, 2311, 2315* (PRE); Whitesands, (–BD), *Esterhuysen 16963* (BOL); De Hoop, Witwater, (–BD), *Van Wyk 2293* (PRE); Farm Meulvlei, (–CA), *Bösenberg & Rutherford 272* (STE); Albertinia, (–CA), *Compton 23519* (NBG); Uyshoek, 7 km N of Arniston, (–CA), *Hugo 843* (PRE, STE); Bredasdorp, (–CA), *Dix 41927* (SAM); Bredasdorp, Skipskop, (–CB), *Acocks 22258* (PRE); Moeratsfontein, between Bredasdorp and Skipskop, (–CB), *Hugo 848* (PRE, STE); De Hoop, between Buffelsfontein and Ryspunt, (–CB), *Van Wyk 2217* (PRE); flats between Bredasdorp and Struis Bay, (–CC), *Levyns 3534* (BOL). **3421** (Riversdale): Plattebosch, (–AA), *Muir 438(5217)* (PRE); between Riversdale and Albertinia, (–AB), *Compton 23327* (NBG); Puntjie along Riversdale coast, (–AB), *Esterhuysen 16976* (BOL); Still Bay, Panorama circle, (–AD), *Bohnen 3823* (STE), *5122* (PRE, STE); Still Bay Reserve, (–AD), *Fellingham 464* (PRE, STE); above bridge at Still Bay strand, (–AD), *Nordenstam 402* (S); Schoemanshoek between Albertinia and The Fisheries, (–BA), *Boucher 3717* (PRE, STE); Albertinia Downs, (–BA), *Muir 1975* (PRE); near Albertinia, (–BA), *Muir 1978* (PRE); Cloetes Pass, Herberdsdale, (–BB), *Zinn 54598* (PRE); 'Canca se leegte', S of Albertinia, (–BC), *Oliver 5722* (STE); Gouriqua, Ystervarkpunt, (–BC), *Willemse 110* (STE); Ystervarkpunt, Aulax Hill, (–BD), *Willemse 162* (STE). **3422** (Mossel Bay): Cloete's Pass, (–AA), *Lewis 5406* (NBG); hill 2.5 km W of Mossel Bay near reservoir, (–AA), *Vlok 1423* (STE); George, Gwaing River, (–AB), *O'Callagan, Fellingham & Van Wyk 226* (STE); George, Christina Bay, (–BA), *Schlechter 2449* (BOL, G, K, PRE, S, STE); Knysna, Buffels Bay, (–BB), *Keet 960* (PRE); Sedgfield, (–BB), *O'Callagan 576* (STE). **3423** (Knysna): Lake Pleasant Hotel, (–AA), *Acocks 21221* (PRE); Groenvlei, (–AA), *Levyns 10310* (BOL); Robberg Nature Reserve, highest point, (–AB), *Taylor 7720* (STE); Robberg Nature Reserve, top of central dune, (–AB), *Taylor 7720a* (STE); Plettenberg Bay, Robberg, (–AB), *Viljoen 62* (PRE).

9. *Disparago laxifolia* DC., *Prodromus systematis naturalis regni vegetabilis* 6: 257 (1837); Harv.: 278 (1894); Levyns: 101 (1936a). Type: 'ad Cap. Bonae-Spei in distr. Caledon ad Zwartberg et Kleinrivier's-berge', *Ecklon s.n.* (G-DC in herb. Dunant, holotype; photo and microfiche in PRE!).

Small trailing shrublets, 100–300 mm tall, branches usually lax and far apart. *Leaves* linear, 3–8(–10) × 0.6–2.5 mm, widely spaced, spirally twisted, usually with ½–1 twist, spreading, older leaves reflexed; margins slightly involute, apices blunt. *Synflorescence* globular aggregation of heads. *Heads* with 1 ray and 1 tubular flower (a single case with 2 ray flowers was observed). *Involucre* of about 6 bracts in 2 series, inner series chaffy, narrowly cymbiform, outer series foliaceous, spatulate. *Ray flowers* sterile, ray 1.5–2.0 × 1.0–1.5 mm, white; cypselas reduced. *Tubular flowers* hermaphrodite; cypselas surface puberulous, apical annulus a well-developed fringe of

hairs. *Pappus* present in tubular flowers, of 5 plumose hairs, not connate.

Distribution: *D. laxifolia* has a very local and scattered distribution that stretches from Simonstown to the Houwhoek Mountains, Grabouw, Caledon and Hermanus. It is very common in the Fernkloof Nature Reserve, near Hermanus (Figure 2).

Specimens examined

CAPE.—**3418** (Simonstown): Redhill, (–AB), *Levyns 5903* (BOL); *Salter 5703* (BOL, K); Peninsula, Sirkelsvlei, (–AD), *Esterhuysen 7793* (BOL); Sir Lowry's Pass (–BB), *Drège s.n.* (P); *Schlechter 595* (PRE), *7223* (BOL, GRA, S); Steenbras area, (–BB), *Levyns 8753* (BOL); Sir Lowry's Pass, Palmiet River, (–BB), *Penther 1415* (S); Cape Point Gap, Klawer Valley, (–BB), *Salter 6426* (BOL, K); near Somersfontein, (–BD), *Boucher 720* (PRE, STE); Betty's Bay, (–BD), *Esterhuysen 34768* (BOL). **3419** (Caledon): Grabouw, Palmiet River, (–AA), *Bolus 5077* (BOL); *Bond 1531* (NBG); *Esterhuysen 35273* (BOL); *Levyns 5358*, *7778* (BOL); *Stokoe 63084* (SAM); Palmiet River Valley, Platteberg, (–AA), *Stokoe 65911* (SAM); Houwhoek, (–AA), *Esterhuysen 33688* (BOL); *Galpin 4152* (GRA, PRE); *Levyns 11404* (BOL); *Schlechter 5447* (BOL, G, GRA, K, PRE, S), *5506* (GRA, PRE); Good Hope Reserve, (–AB), *Wright s.n.* (K); Palmietberg, E of bridge, (–AC), *De Vos 1431* (PRE, STE); Hermanus, Vogelgat Reserve, (–AC), *Esterhuysen 35540* (BOL); Hermanus, Fernkloof Nature Reserve, (–AC), *Koekemoer 192* (PRE); Palmiet River mouth, (–AC), *Koekemoer 439* (PRE); Fernkloof Nature Reserve, (–AD), *Orchard 321* (STE); Vogelgat, Sea Saddle, (–AD), *Williams 2909* (NBG); Caledon, Highlands, (–DB), *Compton 12259* (NBG); Highlands Estate, Elgin, (–DB), *Lewis 63083* (SAM).

Excluded species

Disparago gomphrenoides Sch. Bip.: 180 (1861). Type: C.B.S., *Zeyher 46* (P!) = *Stoebe* sp.

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Studies in the Marchantiales (Hepaticae) from southern Africa. 2. The genus *Athalamia* and *A. spathysii*; the genus *Oxymitra* and *O. cristata*

S.M. PEROLD*

Keywords: *Athalamia*, *A. spathysii*, Cleveaceae, Hepaticae, Marchantiales, *Oxymitra*, *O. cristata*, Oxymitraceae, southern Africa, taxonomy

ABSTRACT

The genera *Athalamia* (Cleveaceae) and *Oxymitra* (Oxymitraceae), each respectively represented in southern Africa by a single species, *A. spathysii* (Lindenb.) Hattori and *O. cristata* Garside ex Perold, are discussed.

UITTREKSEL

Die genusse *Athalamia* (Cleveaceae) en *Oxymitra* (Oxymitraceae), wat in Suider-Afrika elk respektiewelik verteenwoordig word deur 'n enkele spesie, *A. spathysii* (Lindenb.) Hattori en *O. cristata* Garside ex Perold, word bespreek.

ATHALAMIA

Athalamia Falconer in Annals and Magazine of Natural History, Ser. 2,1: 375 (1848); *ibid.*: 397 (1851); Shimizu & Hattori: 52 (1954); S. Arnell: 57 (1963). Type species: *Athalamia pinguis* Falconer.

Clevea Lindb. 9: 289 (1868); Steph.: 769 (1898); Schiffn.: 29 (1893); Howe: 36 (1899); K. Müll.: 368 (1951–1958); Hässel de Menéndez: 133 (1963). Type species: *Clevea hyalina* (Sommerf.) Lindb.

Spathysia Nees ex Trevis.: 439 (1877). Type species: *Spathysia lindenbergii* Trevis. nom. illeg.

Gollaniella Steph.: 74 (1905). Type species: *Gollaniella pusilla* Steph.

Thallus medium-sized, medianly concave, bright green, in crowded patches; on soil in rocky clefts or under overhangs. *Branches* simple or once pseudodichotomously furcate; thickened over midrib, thinning toward undulate, attenuate margins; apex hardly notched, dorsally not grooved. *Dorsal epidermis* hyaline, cell walls sometimes thickened at corners. *Air pores* simple, small, slightly elevated, stellate or hardly so, surrounded by a ring of cells, the radial walls generally thickened, leading below into individual empty air chambers, these in one or several layers, bounding walls chlorophyllose, rarely with smaller cells containing a single, large oil body; storage tissue with rounded cells fairly closely packed together. *Rhizoids* both smooth and pegged. *Scales* hyaline or purple red, in 2 or more forwardly directed ventral rows, extending beyond thallus margins or not, obtusely triangular, appendage long-acuminate.

Monoicous. *Antheridia* embedded in slightly raised central cushion, or all along midline, opening into projecting, conical papillae. *Archegoniophores* dorsal, single

to several along midline, on short unfurrowed stalk, fili-form scales at its top, involucre 1–3, basally connate, each with single, obliquely erect capsule, wall dehiscing by irregular valves, cells with thickening bands. *Spores* rounded distally, somewhat flattened proximally, lacking triradiate mark, densely covered with conical spines. *Elaters* long, tapering, bispiral.

Athalamia spathysii (Lindenb.) Hattori in Shimizu & Hattori in Journal of the Hattori Botanical Laboratory 12: 54 (1954); S. Arnell: 57 (1963); Vanden Berghen: 168 (1965); Volk: 230 (1979). Type: Greece, Corfu, leg. *Spathys* (W, holo.; STR, iso.).

Marchantia spathysii Lindenb.: 104 (1829); Bisch.: 1018 (1835). *Dumortiera spathysii* (Lindenb.) Nees: 171 (1838); Gott. *et al.*: 546 (1846). *Clevea spathysii* (Lindenb.) K. Müll.: 75 (1940); K. Müll.: 374 (1951–1958).

Plagioclasma rousselianum Mont.: 334 (1838). *Clevea rousseliana* (Mont.) Leitgeb in Steph.: 771 (1898). Type: Algeria, 'Boudjareah', Roussel.

Thallus medium-sized, slightly concave along middle, oblong to broadly ovate or obovate (Figure 1A), bright green, sometimes purple along margins, polygonal outlines of subdorsal air chambers clearly visible from above, i.e. reticulate dorsally, central areolae at apex small, enlarging toward margins and then in parallel, radiating rows; air pores tiny, slightly raised, singly placed over each polygonal area, wet; thallus margins clasped together, revealing deep purple, transversely wrinkled underside of wings, dry; in rather crowded patches, simple or once pseudodichotomously furcate. *Branches* (3.5–) 5.0–12.0 × 2.5–7.5 mm, 825–1075 µm thick over midrib, laterally thinning out into attenuate wings; apex slightly notched and dorsally not grooved, with tips of 2 or 3 purple-red ventral scales recurving over edge; margins acute, thin, scalloped, undulate, often somewhat erect, older parts dead, ventrally purple; flanks sloping obliquely; ventral face medianly keeled, green, midrib with row of purple-red scales on either side (Figure 1C).

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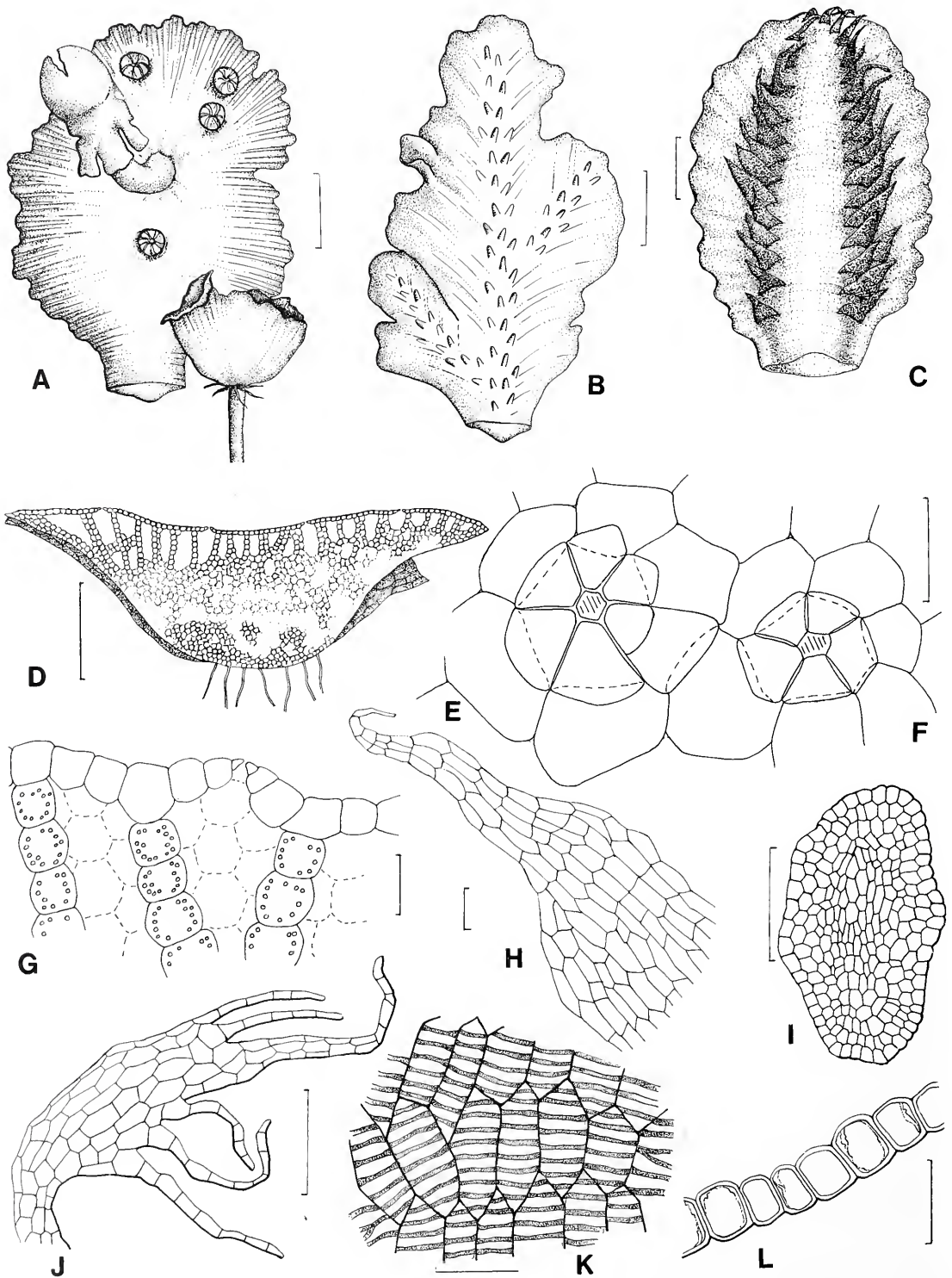


FIGURE 1.—*Athalamia spathysii*. Thalli. A, dorsal view of thallus with stalked archegoniophore and several young sessile ones; inset with archegoniophore and 2 dehiscing sporangia; B, dorsal view of thallus with rows of antheridia; C, ventral view of thallus; D, transverse section of thallus; E, F, dorsal air pores, with thickened radial walls; G, transverse section of air pore; H, ventral scale; I, transverse section of stalk; J, scale from top of stalk; K, capsule wall with cells containing annular thickenings; L, transverse section of capsule wall. A, I–L, *Volk 00589*; B, *Volk 6124*; C–H, *Volk 00904*. Scale bars: A–C, 2 mm; D, 1 mm; E–G, K, L = 50 μ m; H, J = 200 μ m; I = 100 μ m. Illustration by A. Pienaar.

Dorsal epidermal cells unistratose, hyaline, polygonal or isodiametric, $(32.5\text{--}57.5\text{--}62.5 \times 30.0\text{--}42.5 \mu\text{m})$, thin-walled, but frequently thickened at corners, in transverse section $40 \mu\text{m}$ thick; air pores very slightly raised (Figure 1G), simple, small, $7.5\text{--}12.5 \mu\text{m}$ wide, $65\text{--}150 \mu\text{m}$ distant from each other and usually bounded by innermost hyaline circle (Figure 1F), the remains of a collapsed cell ring, otherwise surrounded by a ring of 4–6(–7) bluntly triangular cells, $15.0 \times 22.5\text{--}32.0 \mu\text{m}$, the radial walls mostly thickened and pores thus stellate (Figure 1E, 1F), partly overlying adjacent dorsal cells. *Assimilation tissue* $350\text{--}500 \mu\text{m}$ thick with air chambers empty, in one layer or sometimes in several layers, $50\text{--}95 \mu\text{m}$ wide, vertical or sloping forward, oblique laterally (Figure 1D), unistratose walls consisting of chlorophyllose cells, roundish or oval, $40.0\text{--}62.5 \times 45.0 \mu\text{m}$; storage tissue $\pm 600 \mu\text{m}$ thick, cells fairly densely packed together, rounded, up to $62.5 \mu\text{m}$ wide; rhizoids mostly smooth, $25\text{--}35 \mu\text{m}$ wide. *Scales* purple-red, arranged in 2 forwardly directed ventral rows, one on either side of midrib, not or somewhat extending beyond margins of thallus, recurved at apex, obtusely triangular (Figure 1H), margins entire or sometimes slightly dentate on oblique side of base, not constricted where joined with acuminate, apically pointed and tapering appendage, total length (including $750 \mu\text{m}$ appendage) $\pm 1300 \mu\text{m}$, width at base up to $1000 \mu\text{m}$, cells (4-)5- or 6-sided, $90\text{--}137 \times 40\text{--}50 \mu\text{m}$; oil bodies absent.

Monocious, but occasionally only antheridia or archegonia found. *Antheridia*, when present with archegonia in a group, proximal to archegoniophore, embedded in central, slightly raised, ill-defined cushion lacking scales, otherwise in rows along entire middle of thallus (Figure 1B), sunken, saccate, $500 \times 230 \mu\text{m}$, narrowed at neck, opening into raised, conical papillae projecting $200 \mu\text{m}$ above surface and $300 \mu\text{m}$ wide at base. *Archegoniophores* single or several, linearly and acropetally arranged on dorsal

face, when young sessile, rounded, and basally surrounded by inconspicuous, filiform scales, air pores and air chambers lacking; stalk cylindrical, pellucid, eventually $1.6\text{--}7.0 \text{ mm}$ long, round to ovate in cross section (Figure 1I), diameter $250 \mu\text{m}$, without rhizoidal furrow; scales eventually carried upwards and then only present at top of stalk, where joined to archegoniophore, hyaline or pink, basally $750 \times 500 \mu\text{m}$, with 4 or 5 filiform, apical strands (Figure 1J), up to $750 \mu\text{m}$ long, cells $75 \times 48 \mu\text{m}$; archegoniophore white to greenish white, central disc absent, with 1–3 involucre, connate at their bases and attached to top of stalk, bilabiate by vertical cleft, each with single capsule, brown, globular, $1250 \mu\text{m}$ in diameter, borne obliquely erect on $850 \times 600 \mu\text{m}$ seta with bulbous foot, dehiscing by several irregular valves, wall unistratose (Figure 1L), cells spindle-shaped, up to $75 \times 30 \mu\text{m}$, with annular or spiral thickening bands (Figure 1K). *Spores* $(60\text{--})65\text{--}75\text{--}(78) \mu\text{m}$ in diameter, globular, with distal face convex (Figure 2A, B), no triradiate mark on somewhat flatter proximal face, golden brown, semitransparent, thickly covered with dense conical spines (Figure 2A–D), $5 \mu\text{m}$ high and $15 \mu\text{m}$ wide at base, sprinkled with fine granules (Figure 2E). *Elaters* yellow-brown, slightly tapering toward ends, $275\text{--}350 \mu\text{m}$ long, $7.5\text{--}10.5 \mu\text{m}$ wide in middle, bispiral (Figure 2F), very occasionally branched, sometimes bent. *Chromosome number*: $n = 9$ (Bornefeld 1987); as *Clevea rousseliana*: $n = 9$ (Heitz 1927).

DISCUSSION

Athalamia spathysii is rarely collected in southern Africa, the gatherings by Volk (1979) being restricted to Namibia (Figure 3). It grows in periodically dry areas, on soil overlying slate, granite or sandstone, in rocky crevices or under overhangs, where runoff may be concentrated and some protection against radiation is afforded; sometimes it occurs together with *Plagiochasma* spp., *Targionia*

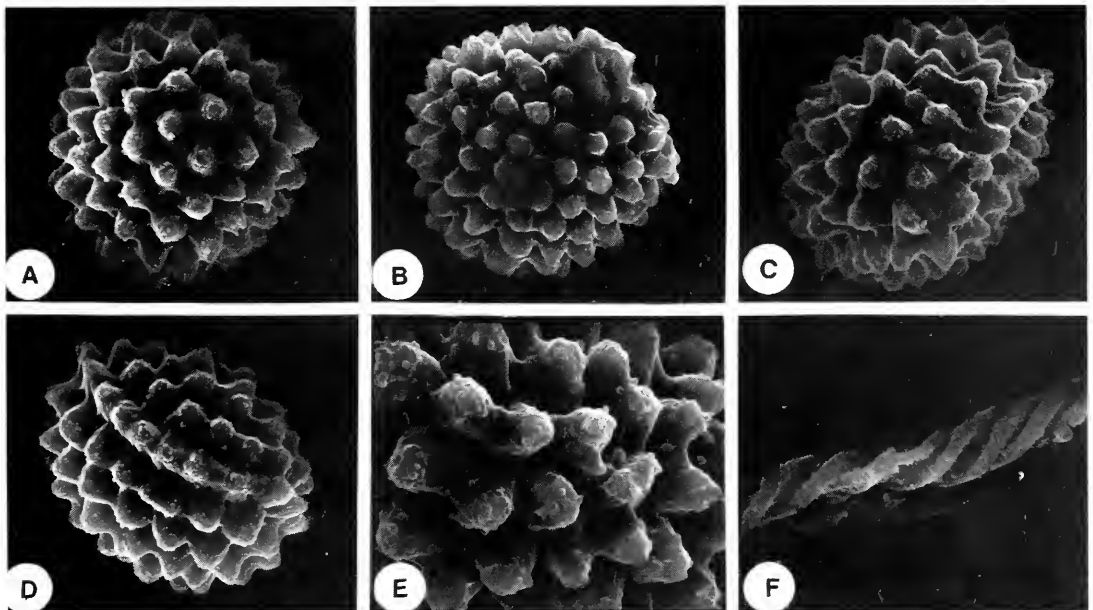


FIGURE 2.—*Athalamia spathysii*. SEM micrographs of spores. A, B, distal face; C, side view of distal face; D, side view of both faces; E, spinous processes much enlarged; F, elater. A–F, Volk 00589. A–D, $\times 580$; F, $\times 1000$.

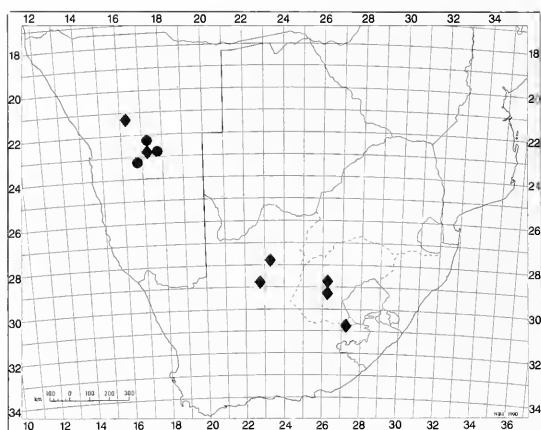


FIGURE 3.—Distribution of *Athalamia spathysii*, ●, and *Oxymitra cristata*, ♦, in southern Africa.

hypophylla etc., but is distinguished from them by the reticulate dorsal surface, small and slightly raised, mostly stellate air pores, empty air chambers, scales with acuminate appendages, cells of the capsule wall with spiral thickenings and by bluntly spinous spores.

It has also been reported from further north in Africa, i.e. from Tanzania (= Tanganyika) by Vanden Berghen (1965). *Athalamia spathysii* is furthermore known from Israel, North Africa, the Canary Islands and the Mediterranean countries (Müller 1951–1958), the type specimen having been collected at Corfu. Frey & Kürschner (1988) report it from Yemen and Oman in the Arabian Peninsula, and state that its distribution includes Turkey and Jordan.

Athalamia is classified in the family Cleveaceae Cavers, together with the genera *Peltolepis* Lindb. and *Sauteria* Nees, but neither of the latter two occur in southern Africa.

There are at least 10 species world-wide in the genus *Athalamia*, with *A. spathysii* the only representative in southern Africa. *A. pulcherrima* (Steph.) Hatt. being from Ethiopia and distinguished by larger, hyaline ventral scales and cells with much thickened radial walls surrounding the dorsal air pores. Another species recorded from Africa, in Algeria, is *Clevea* (*Athalamia*) *trabutiana* Steph., but it is regarded by Grolle (1976) as conspecific with *A. hyalina* (Sommerf.) Hatt. In *A. spathysii* the radial walls of the pore cells are only somewhat thickened, a possible response to growing in sunlight, as was found in cultivation studies by Müller (1951–1958). Shimizu & Hattori (1954), however, reported for this genus, that they had observed pores with both thickened radial walls (stellate) or with thin walls (not stellate) on the same plant!

According to Müller (1939), Arnell (1963), Vanden Berghen (1968) and Volk (1979) oil bodies are absent in the genus *Athalamia*. I also found them to be absent in *A. spathysii*, but fresh material was not available for study. Shimizu & Hattori (1954), however, reported oil cells in *Athalamia glauco-virens* as well as in *A. nana* (Shimizu & Hattori 1955). Schuster (1992) states that sparse, scattered oil cells may be present or absent.

Asexual reproduction is said to be absent. Stephani (1895) suspected that adventitious growth in the form of ventral shoots from the costa was partly the reason for the 'dichten verfilzten niedrigen Rasen' in *Clevea pulcherrima* Steph. As in *Plagiochasma* spp., the apical part of the thallus continues to grow and increase in length, beyond the archegoniophore after the latter has differentiated.

Kashyap (1915) described a mycorrhizal region in the midrib of *A. pinguis*, the hyphae having penetrated the thallus via the rhizoids. Sterile specimens of *A. spathysii* have been confused with *Asterella muscicola* (Arnell 1957), because of the stellate dorsal pores, but the latter does not grow in Namibia (Volk 1979), its ventral scales have scattered oil bodies, the stalk has a rhizoidal furrow and the capsule wall lacks thickenings.

Specimens examined

NAMIBIA.—2217 (Windhoek): WIN 63 (Neudamm), schattige Glimmerschieferfelsen am Rivier, (–AD), Volk 00952 (BOL; PRE); unterhalb Brücke, Glimmerschiefer, (–AD), Volk 86-877 (Herb. Volk); 1 mile west of Windhoek, (–CA), Schelpe 4763 (BOL); WIN 62, Hatsamas/Dordabis, Kalkfels, (–DC), Volk 00589 p.p. (Herb. Volk). 2218 (Gobabis): WIN 70, schattiges Tälchen an den Gobabisstrasse, Glimmerschiefer, (–??), Volk 00904 (BOL; PRE). 2316 (Nauchas): WIN 39 (Mahonda), schattige Überhänge, Glimmerschiefer, (–BA), Volk 6124 (PRE).

OXYMITRA

Oxymitra Bisch. ex Lindenb., Synopsis hepaticarum europaeorum: 124 (1829); Gott., Lindenb. & Nees: 597 (1846); Frye & Clark: 40 (1937); K. Müll.: 410 (1951–1958); Hässel de Menéndez: 200 (1963); Arnell: 11 (1963). Lectotype species: *O. incrassata* (Brotero) Sérgio & Sim-Sim.

Pycnoscenus Lindb.: 606 (1863), nom. illeg.

Tessellina Dumort.: 164 (1874), non Dumort.: 78 (1822) orth. var.: *Tessellina* Dumort. mut., Schiffn.: 15 (1893). Type species: *Tessellina coriandrina* (Spreng.) Dumort.

Thallus medium-sized, deeply and sharply grooved dorsally, pale green to deep green, in gregarious or rosette-like stands; rare, on soil, sometimes derived from ironstone. *Branches* broadly ovate or oblong, pseudo-dichotomously furcate; thickened over midrib, thinning toward margins; apex emarginate. *Dorsal epidermis* hyaline, persistent. *Air pores* tiny, simple, radial walls thickened, stellate, leading below into tall, narrow, subvertical, empty air chambers, bounded by unistratose, chlorophyllose cell walls. *Storage tissue* with rounded or angular cells, closely packed together; rhizoids numerous, some smooth, others pegged. *Scales* large and conspicuous, arising ventrally and projecting far above thallus margins, triangular, dark red to almost black or hyaline.

Monoicous or dioicous. *Antheridia* medianly grouped behind archegonia or mixed with them when monoicous, embedded, with hyaline necks projecting, at their bases surrounded by capillary hairs, vestigial or prominent. *Archegonia* several in a row along midline, flask-shaped, protected in a continuous, crest-like, fleshy involucre, or

individually enclosed in conical or pyramidal, chambered involucre with scales around the base. *Sporangia* without stalk or foot, globose, capsule wall hyaline, unistratose, delicate. *Spores* triangular-globular, anisopolar, black, opaque; distal face with several large areolae, containing a central nodule or not; proximal face with triradiate mark distinct or not, irregularly reticulate or smooth. *Elaters* absent, but some sterile cells reputed to be present.

***Oxymitra cristata* Garside ex Perold, sp. nov.**
Type: Cape, near Bredby Mine (25 miles S of Kuruman), *Schelpé 5900* (BOL, holo.).

Frondes caespitosae confertae, virides; squamae ventrales atro-violaceae, oblique triangulares, marginem frondis bene superantes. Antheridia in pulvillis medianos lineares immersa. Archegonia ante antheridia posita, in serie unica lineari disposita atque in involucri connata immersa, cristam medianam prominentiam crenatam formantia, bracteae desunt. Sporae 100–115 µm diametro: exterior (distalis) facies irregulariter reticulata, interior (proximalis) facies laeves.

O. incrassata, species altera generis, archegoniis in involucri concis vel pyramidalibus singulatis inclusis, bracteis multis concomitatis ab *O. cristata* differt.

Thallus smallish to medium-sized, apically emarginate, dorsally deeply grooved along entire midline (Figure 4A, C), except where interrupted by gametangia, broadly ovate or oblong, bright green to deep green, dark red along margins, sometimes bronze-brown proximally, forming a broad, deeply coloured 'V' over base, reticulate from above, with outlines of subdorsal air chambers clearly visible, air pores tiny, hardly raised (Figure 4G), numerous but singly placed above each polygonal air chamber, wet; thallus margins incurved or raised and tightly clasped together, flanks covered by large, triangular, shiny dark red scales, dry; in crowded, overlying patches, once to several times pseudodichotomously furcate. Branches (3–)5–10(–12) × 2.5–4.8 mm, 1100–2000 µm thick over midrib; margins rather obtuse to acute, scalloped or undulating, much exceeded by projecting, triangular scales; flanks deep purple, steeply rising (Figure 4C), to sloping obliquely upward and outward (Figure 4D); ventral face rounded to flattish, green (Figure 4B).

Dorsal epidermal cells unistratose, hyaline, from above polygonal, (22.5–)37.5–45.0(–52.0) × 27.5–37.5(–47.5) µm, in transverse section brick-shaped, 25–35 µm thick. *Air pores* stellate (Figure 4H), small, simple, slightly raised (Figure 4G), 5–10 µm wide, 4- or 5-(6)-sided (Figure 4H), 75–112 µm distant from each other, bounded by 4 or 5, rarely 6, small, bluntly wedge-shaped cells, 12.5–15.0 × ± 25 µm across base, radial walls slightly thickened, partly overlying, or occasionally adjoining larger, polygonal cells. *Assimilation tissue* 400–600 µm thick with air chambers empty (Figure 4F), in one layer, 32–65 (–100) µm wide, bounding walls unistratose, cells 37–47 × 25–35 µm; storage tissue composed of rounded or angular cells, ± 50 µm wide. *Rhizoids* numerous, 17–25 µm wide, some pegged, others smooth. *Scales* arising ventrally and projecting up to 375 µm above thallus margins, dark red to almost black, shiny, basal part of apical scales hyaline, densely imbricate, obliquely triangular (Figure

4I), 1250–1375 µm long, 1075–1200 µm wide across base, margins entire, sometimes crenate or shortly toothed toward base of forwardly directed side, cells in body of scale (4-)5- or 6-sided, ± 100 × 25 µm, smaller at rounded margin.

Monoicous. *Antheridia* in a row along midline, proximal to archegonia (Figure 4A, E), immersed, necks hyaline, cylindrical, 75 µm wide, protruding 210 µm above dorsal surface. *Archegonia* in a median row, in flask-shaped cavities, partly sunken into thallus and as a group enclosed above by a 600 µm high, irregular, crest-like, fleshy ridge (Figure 4D), tinged reddish on top around openings of archegonial necks, these long and turning purple with age. *Sporangia* ventrally partly sunken into thallus, dorsally bulging on either side of central crest, capsule ± 750 µm wide, wall hyaline, thin and delicate. *Spores* (108–)110–115(–125) µm in diameter, triangular-globular, polar, black, opaque, wing ± 5 µm wide, entire, anisopolar, with ornamentation different on two faces: distal face (Figure 5A–C) with 6 or 7 large central areolae, up to 30 µm wide, smaller toward margin, generally with a nodule and thin radiating ridges in the middle of each, areolar walls thick; proximal face with triradiate mark distinct (Figure 5D, E), 3 facets with incomplete areolae, walls irregular (Figure 5E, F), sometimes rather indistinct (Figure 5D). *Chromosome number* n = 18 (Baudoin 1976).

DISCUSSION

Grolle (pers. comm.) has pointed out to me that *O. cristata* Garside was invalidly published as it did not comply with Art. 37.1 of ICBN because it was published after 1 January 1958 without indication of the holotype. Garside's paper was published in April 1958 and two type specimens were cited: *Schelpé 5900* and *Duthie 5531*, but no holotype was designated. *Oxymitra cristata* Garside ex Perold is therefore accordingly newly described here, together with a Latin diagnosis; *Schelpé 5900* is designated as the holotype.

Oxymitra cristata is endemic to southern Africa, and very rarely collected. Garside (1958) remarked that 'the detailed geographical distribution is not yet completely known' and this is still true today, only a few more collections having been made during the intervening 35 years. It is known from Namibia, Orange Free State and northern and eastern Cape (Figure 3). It has been found mainly on substrates derived from ironstone, and it occasionally grows in association with *Plagiochasma* spp. and *Riccia* spp. *Oxymitra cristata* is distinguished by its large, obliquely triangular, shiny, dark red scales and by the row of archegonia enclosed in an irregular, but continuous, crest-like, fleshy ridge of tissue. Garside (1958) regarded the ridges as composed of fused involucre. In the only other species in the genus, *O. incrassata* (Brotero) Sérgio & Sim-Sim, better known as *O. paleacea* Bisch. ex Lindenb. (Sérgio & Sim-Sim 1989), each archegonium is individually enclosed in a conical or pyramidal involucre, containing air chambers and air pores. These involucre are arranged in two rows along the midline and are accompanied by numerous bracts. *Oxymitra incrassata* also differs from *O. cristata* by its hyaline ventral scales, by its spore ornamentation, with the areolae on the distal face lacking a central nodule and by the smooth facets on the

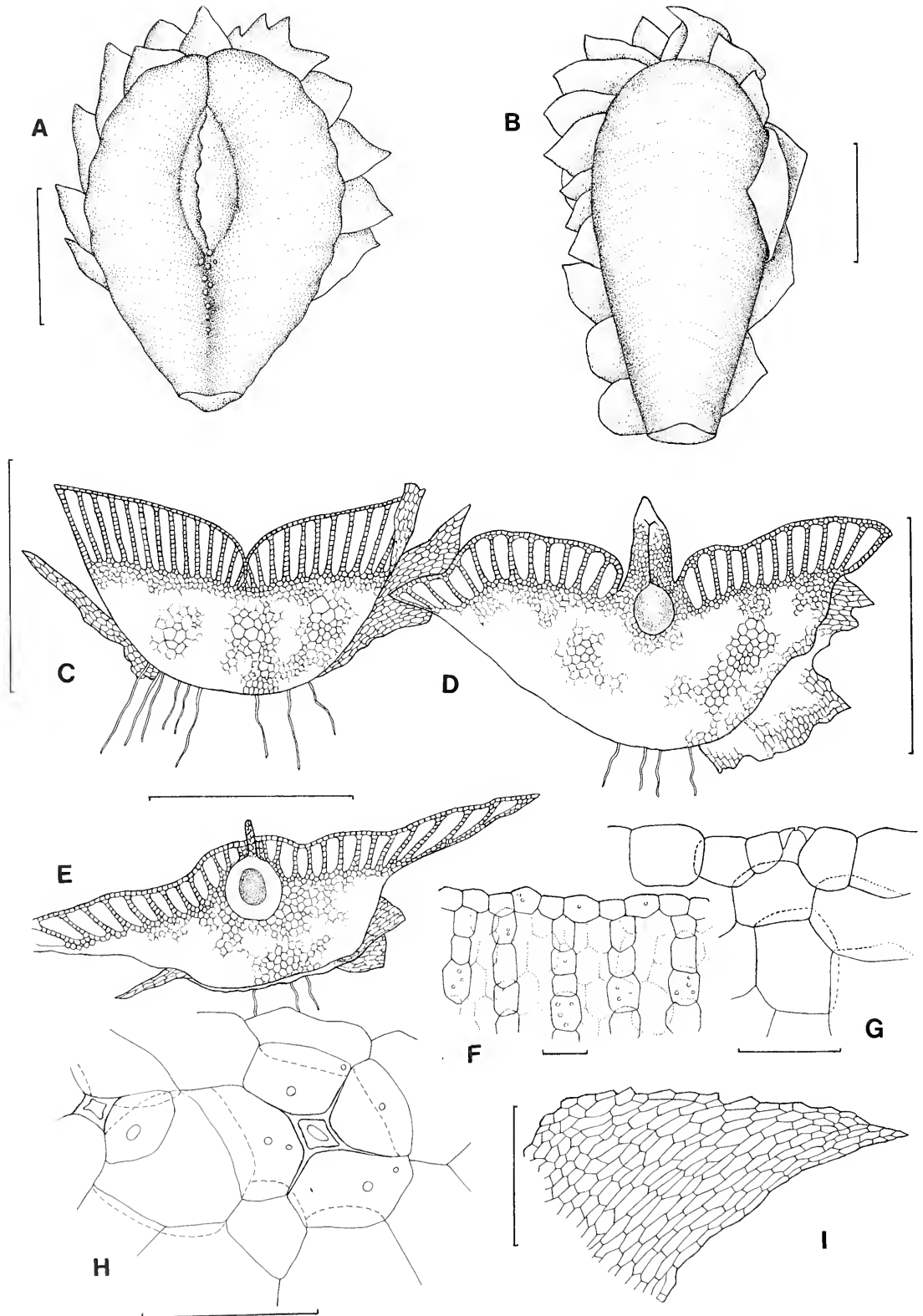


FIGURE 4.—*Oxymitra cristata*. Thalli. A, dorsal view of thallus with crest-like involucre and, proximally, row of antheridia; B, ventral view of thallus; C, transverse section of thallus through dorsal groove; D, transverse section of thallus through involucre with archegonium; E, transverse section through antheridia, dorsal cells and air chambers; G, transverse section through much enlarged air pore; H, air pore and surrounding cells seen from above; I, ventral scale. A, B, D, *Volk 00906*; C, F–I, *Volk 81/050*; E, *Volk 00957*. Scale bars: A–E, 2 mm; F–H, 50 µm; I, 500 µm. Illustration by A. Picnaar.

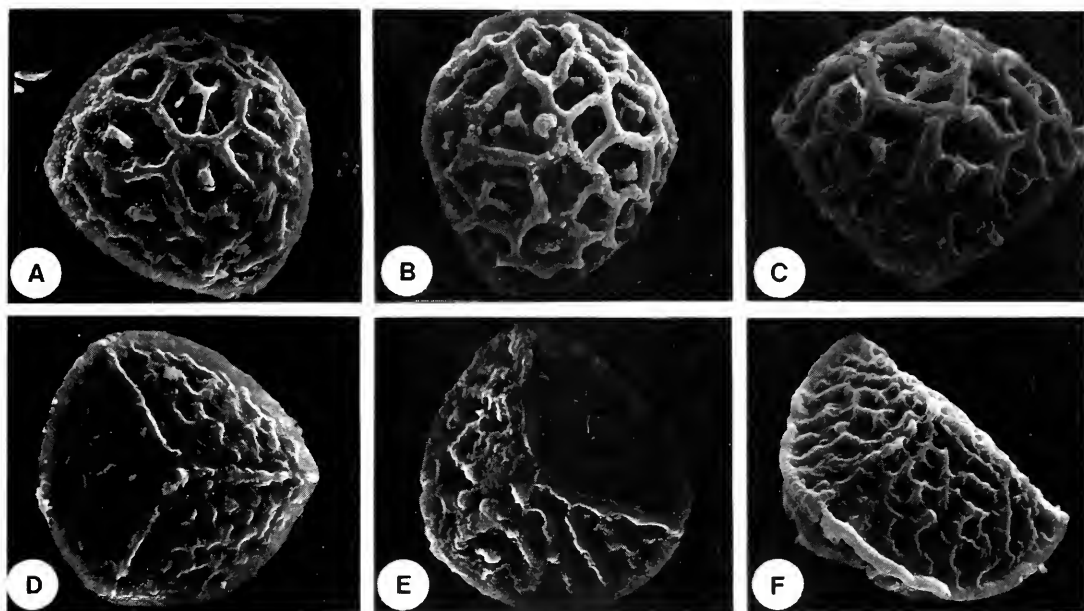


FIGURE 5.—*Oxymitra cristata*. SEM micrographs of spores. A, B, distal face; C, side view of distal face; D, E, proximal face; F, side view of proximal face with areolar walls more pronounced. A, D, Volk 00906; B, C, E, F, Volk 5050. A, B, D, E, $\times 320$; C, F, $\times 345$.

proximal face, by the chromosome number $n = 9$ and by its distribution: it is known from Europe, North Africa, the Canary Islands, North and South America.

Bischler (1988) records the presence of tubers in *Oxymitra*, but these have not been observed in the present investigation of *O. cristata*. The two species of *Oxymitra* are placed in the family Oxymitraceae K. Müll. ex Grolle. The sporangia, partially embedded in the thallus tissue, the loss of a foot and seta of the capsule, the absence of elaters, spore release only after destruction of surrounding tissue and the sporeling type (Baudoin 1976), all indicate the relationship of Oxymitraceae to Ricciaceae, and they have been classified together in the suborder Ricciineae (Schuster 1984), although Schier (1974), on the basis of biochemical studies, had segregated the Oxymitraceae into their own suborder, the Oxymitrineae.

Oil bodies have not been observed in *O. cristata*, but Müller (1939) reports their presence (after Györfy) in the storage tissue of *O. incrassata* during spring and autumn. The generic description has had to be emended somewhat to accommodate the gametangial differences in the two species, the first set of particulars in each case referring to *O. cristata*.

SPECIMENS EXAMINED

NAMIBIA.—2216 (Otjimbingwe): OM 37 Otjua, (—AA), Volk 00957 (herb. Volk). 2217 (Windhoek): Voigtland, feuchte Klüfte, (—CB), Volk 5050 (herb. Volk). 2218 (Gobabis): WIN 70, schattiges Tälchen, Glimmerschiefer (+ *Plagiochasma* sp. & *Athalamia spatulifolia*), (—??), Volk 00906 (PRE, herb. Volk).

O.F.S.—2826 (Brandfort): Glen Agricultural College, on stony kopje, (—CD), Zietsman 943 (PRE). 2926 (Bloemfontein): Bloemfontein, Botanical Garden, not cultivated part, on hill, (—AA), Volk 81/050 (PRE); Bloemfontein, next to Botanical Garden, shallow soil over rock, (—AA), Volk 81/291 (PRE); Bloemfontein, near Hillandale, (—AA), Gemmell

(=Duthie 5501) (BOL); Bloemfontein, Eagle's Nest, on ironstone kopje, in shelter of grass and boulders, (—AA) Gemmel & Lutjeharns (=Duthie 5460) (BOL).

CAPE.—2723 (Kuruman): near Bredby Mine, 25 miles S of Kuruman, (—CA), Schelpe 5900 (BOL) (holotype). 2822 (Glen Lyon): Olifantshoek area, on farm belonging to Mr Rossouw, on stony koppie, with *Riccia* spp. and *Plagiochasma* sp. (—BA), Koekemoer 1024 (PRE); Griqualand West, Groenwater Valley, Hay, east of Postmasburg (sic) [Postmasburg], (—DD), Cooke s.n. (=Duthie 5531) (BOL). 3027 (Lady Grey): Herschel, mudbanks of Sterkspruit, with *Riccia* sp., (—CB), Hepburn CH 1043 (PRE).

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Studies in the Marchantiales (Hepaticae) from southern Africa. 3. The genus *Targionia* and *T. hypophylla* with notes on *T. lorbeeriana* and *Cyathodium foetidissimum* (Targioniaceae)

S.M. PEROLD*

Keywords: *Cyathodium*, Hepaticae, Marchantiales, southern Africa, *Targionia*, Targioniaceae, *T. hypophylla*, *T. lorbeeriana*, Targioniodeae

ABSTRACT

A taxonomic account of the genus, *Targionia*, and its only representative in southern Africa, the almost cosmopolitan *T. hypophylla*, is given here. Much more southern African and other material, than was available to the previous authors, Sim (1926) and Arnell (1963) has been examined.

Material collected at Knysna by Duthie was identified by Arnell (1963) as *Cyathodium foetidissimum*, but is shown to have been misidentified and is actually a specimen of *Riccia rubricollis*. The presence of the genus, *Cyathodium* in southern Africa, has not been confirmed.

UITTREKSEL

'n Verslag oor die genus *Targionia* en sy enigste verteenwoordiger in Suider-Afrika, die byna kosmopolitiese *T. hypophylla*, word hier gegee. Baie meer materiaal is ondersoek as wat vir die vorige outeurs, Sim (1926) en Arnell (1963), beskikbaar was.

Materiaal wat Duthie by Knysna versamel het, is deur Arnell (1963) geïdentifiseer as *Cyathodium foetidissimum*. Dit is egter verkeerdlik benaam en die materiaal is 'n voorbeeld van *Riccia rubricollis*. Die teenwoordigheid van die genus *Cyathodium* in Suider-Afrika is nie bevestig nie.

Targionia (Micheli) L., Species plantarum 2: 1136 (1753); Gott. *et al.*: 574 (1846); Schiffn.: 26 (1893); Steph.: 763 (1898); Macvicar: 33 (1926); Sim: 16 (1926); K. Müll.: 325 (1951–1958); Hässel de Menéndez: 68 (1963); Arnell: 46 (1963). Type species: *Targionia hypophylla* L.

Thallus, medium-sized, fleshy, lobes linear, sometimes widening toward apex or cordate, somewhat leathery, light green to darker green, often with a waxy bloom, in crowded patches or extensive sheets; on soil in sheltered rocky clefts or a pioneer on disturbed soil.

Branches often simple, sometimes repeatedly furcate or only apically branched, or with ventral innovations; thickened over midrib, rather abruptly thinning into wings; apex notched, tips of scale appendages curving backwards over it; not grooved. *Dorsal epidermis* hyaline, cell walls thickened, especially at corners; air pores simple, conspicuous, slightly raised, with 3 concentric rings of cells, their walls thin, leading below into shallow air chambers containing chlorophyllose filaments; oil cells present; storage tissue 3–5 times thicker than assimilation tissue above; ventrally purple-black; some rhizoids smooth, others pegged. *Scales* in one row on each side of midrib, dark purple, large, obliquely triangular with broadly 'awl'-shaped appendage.

Autoicous or dioicous. *Antheridia* mostly embedded in swollen disciform apex of small male branch, arising ventrally at side of midrib and emerging laterally. *Archegonia*

formed at apex of thallus, and subsequently capsule displaced to just below apex, enclosed in bivalved involucre which opens at central narrow vertical fissure; capsule wall cells with annular thickening bands. *Spores* convex distally, ornamented with a double network, the larger network forming strongly raised, rounded ridges which enclose polygonal areas, all covered by a reticulum of smaller, fine ridges. *Elaters* bispiral, sometimes branched.

***Targionia hypophylla* L.**, Species plantarum: 1136 (1753); Steph.: 764 (1898); Macvicar: 33 (1926); Sim: 16 (1926); K. Müll.: 326 (1951–1958); Hässel de Menéndez: 69 (1963); Arnell: 46 (1963); Volk: 241 (1979); Piippo: 274 (1991). Types: 'Italia, Hispania, Constantinopoli' + citation (syn.); (OXF, syn.) Dill.: 532. Lichen no. 9, tab. 78, fig. 9. (1741); (H-SOL, isosyn.) [according to Isovita (1970) and quoted by Grolle (1976)].

T. micheli Corda: 649 (1829). Type: Italy, leg. Sieber.

T. mexicana Lehm. & Lindenb. in Lehm.: 27 (1832). Type: Mexico, leg. Schiede.

T. capensis Hübener: 17 (1834).

T. hypophylla var. *capensis* (Hüb.) Krauss: 135 (1846). Type: Cape, 'in promont. bonae Spei', leg. Zeyher.

T. bifurca Nees & Mont. in Mont.: 113 (1838); Nees: 315 (1838). Type: Chile, 'prope Quillota', leg. Brotero.

T. convoluta Lindenb. & Gott. in Gott. *et al.*: 576 (1846). Type: Mexico, ad Chinantla, leg. Liebman.

Thallus medium-sized, somewhat leathery, linear to ligulate, apically often slightly broader, dark green, sometimes with bluish tint, marginally purple and entire to somewhat crenate or scalloped, flat above, not grooved,

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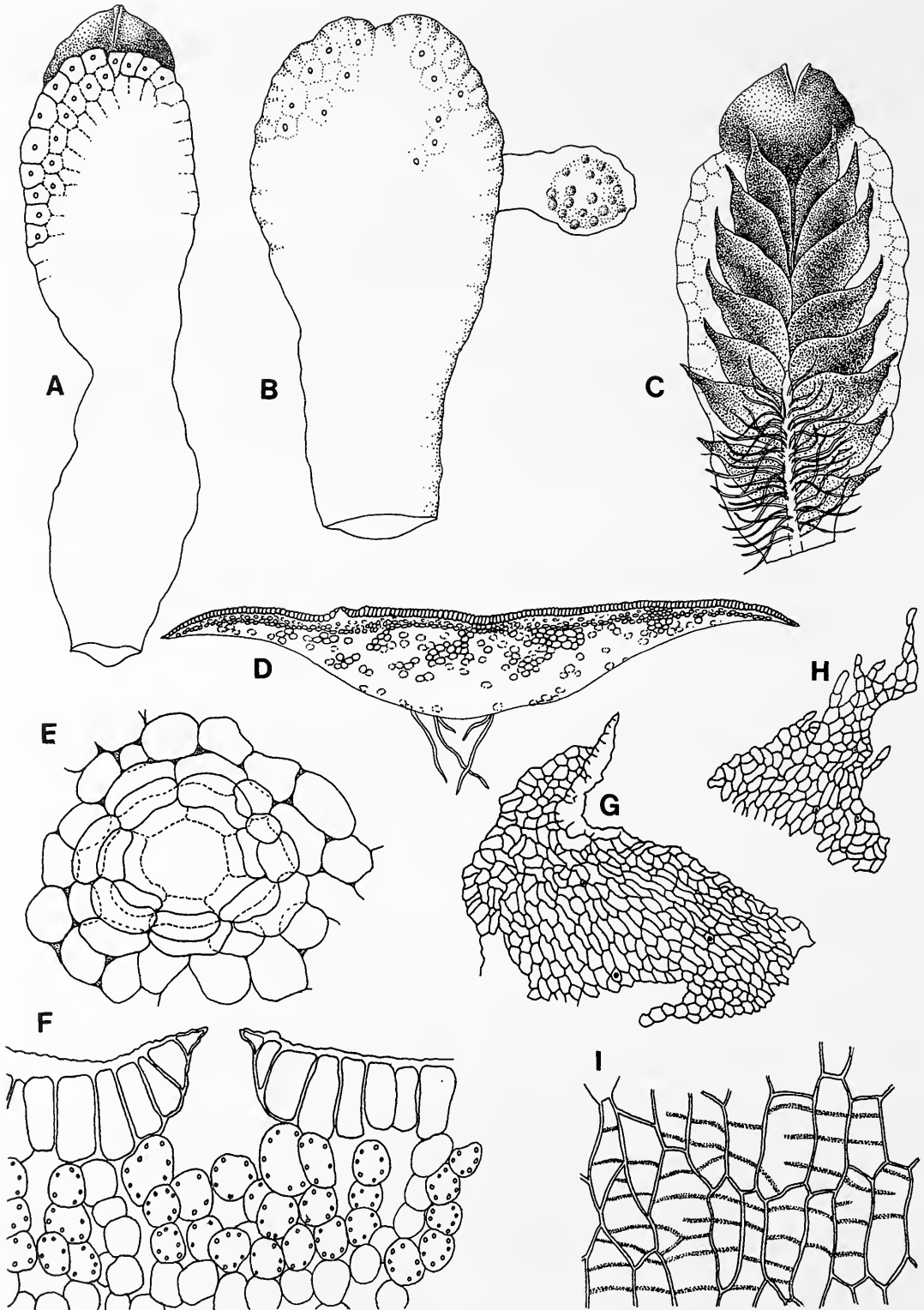


FIGURE 1.—*Targionia hypophylla*, A, dorsal aspect of thallus with tip of involucre protruding at apex; B, thallus with short ventrally innovating branch bearing terminal disc with antheridia; C, ventral aspect of thallus with pouch-like involucre at apex and 2 rows of ventral scales; D, transverse section of thallus; E, air pore from above; F, transverse section of air pore, dorsal cells and chlorophyllous filaments; G, scale with margins \pm intact; H, scale with fimbriate appendage; I, cells of capsule wall with thickening bands. A, C, D, F, I, Koekemoer 477a; B, E, G, Garside 6674; H, Schelpe 4947. A, B, C, $\times 11$; D, $\times 22$; E, $\times 300$; F, $\times 275$; G, H, $\times 55$; I, $\times 250$.

polygonal outlines of subdorsal air chambers clearly visible from above, each with large and well-spaced air pore, wet (Figure 1A); flanks ventrally deep purple and frequently incurved, branches becoming almost tubular, or sides clasped together, mostly covering dorsal epidermis with its conspicuous white-encircled air pores, distal ventral scales exposed, leading branch often becoming erect and elevating ventral sporophyte, dry; in crowded patches, simple to repeatedly furcate or with ventral or apical innovations. *Branches* 5–10 mm long between furcations, total length up to 30 mm, 2.7–3.5 mm wide, 550 μ m thick over midrib, laterally thinning out into wings; apex slightly notched with tips of scales reflexed over edge in sterile plants or, when female receptacle present, entire and lacking apical scales; margins acute, thin, ventrally purple; flanks sloping obliquely outward and upward (Figure 1D); ventral face medianly keeled, mostly purple, on either side of midrib with row of imbricate, apically directed, purple to reddish \pm triangular scales (Figure 1C). *Dorsal epidermal cells* unistratose, hyaline, from above rounded to oval, 22.5–37.5 \times 17.5–25.0 μ m, trigones conspicuous, in transverse section cells \pm 45 μ m high, rectangular, lateral walls thickened; marginal cells mostly purple, from above rectangular, trapezoid or triangular, (25–)30–45(–50) \times 20–32 μ m, second row purple as well or sometimes hyaline, also variable in shape and size, 22.5–50.0 \times 15.0–17.5 μ m, an inner third or fourth row of cells frequently also present, all lacking trigones; marginal cells at apex of thallus (17–)22–35 \times (12–)25–37 μ m; air pores somewhat raised, simple, 52.5–67.5 \times 35.0–40.0 μ m, oval or rounded (Figure 1E), 250–375 μ m distant from each other, bounded by 3 concentric rings of cells: innermost annular row of \pm 6 thin-walled, curved, hyaline cells, \pm 15 \times 25 μ m, the remains of a collapsed cell ring, next row of 8–11 sausage-shaped cells, \pm 22 \times 30 μ m, slightly thicker-walled, partly overlying outermost row of 14 also sausage-shaped cells, \pm 27 \times 35 μ m; assimilation tissue with air chambers in one layer, \pm 80 μ m thick, containing simple or branched, 2- or 3-celled chlorophyllose filaments, cells (20.0–)22.5–34.0 \times 25.0 μ m, those below air pores larger (Figure 1F), 47.0 \times 37.5 μ m, with numerous chloroplasts, and except at air pores, in close proximity to dorsal cells; storage tissue \pm 425 μ m thick, cells closely packed, angular, variable in size, 17.5–50.0 μ m wide, occasional cells with oil bodies, \pm 27.5 μ m wide; rhizoids mainly between scales, some smooth, others pegged, \pm 15 μ m wide. *Scales* in 2 longitudinal rows, one on either side of costa, reddish to dark purple, obliquely triangular, imbricate, not or hardly reaching thallus margins, 875–1750 μ m long and up to 1325 μ m wide at base, if receptacle present, those covering it proximally larger, 2250 μ m in length, basally up to 2000 μ m wide, apically continuing into single, forwardly directed, long-acuminate appendage (Figure 1G), \pm 375 μ m long; cells in body of scale 4–6-sided, \pm 80.0 \times 17.5 μ m, in appendage 32.5–62.5 \times 22.5–27.5 μ m, below appendage, polygonal, (20–)37–60 \times 25–45 μ m, scattered oil cells present, margin entire or not, sometimes with single-celled papillae, 30.0 \times 17.5 μ m or with fimbria (Figure 1H) \pm 75 \times 25 μ m or longer, especially at appendage of apical scales.

Autoicous or dioicous. *Androecia* borne on short, ventrally innovating branches, protruding at sides of thallus, on terminal disc, 1.3–1.8 mm wide, 750 μ m thick and encircled above by low, frilly membrane; *antheridia* seve-

ral, with conical protruberances, 150 μ m high, each with opening leading into antheridial cavity below. *Gynoecea* terminal, enclosed in large, \pm 3125 \times 3600 μ m, shiny black, mussel-like, bivalved involucre, displaced below apex of thallus, wall 4-layered, cells in outer layer thick-walled on outside, 4–7-sided, 62.5–150.0 \times 32.5–45.0 μ m, in inner layers thin-walled, elongated, \pm 100 \times 40 μ m, interspersed with numerous oil cells; to release spores and elaters, involucre opening along narrow central vertical fissure fringed with several irregular, cellular protuberances; pseudoperianth lacking; calyptra hyaline, delicate, cells irregular in shape and size, 45.0–55.0 \times 27.5 μ m; capsule sessile, spherical, wall yellowish brown, cells \pm rectangular to mostly spindle-shaped, \pm 75 \times 35 μ m, with thickening bands (Figure 1I) \pm 5 μ m wide. *Spores* (47–)62–77(–95) μ m in diameter, light brown to brown or dark reddish brown, anisopolar, 2 faces different in shape and ornamentation, distal face convex, rounded, with double network (Figure 2A, D–F), the larger network consisting of raised, rounded ridges, enclosing 16 or 17 polygonal areas, 12.5–17.5 μ m wide, all covered by superimposed, fine reticulum, the areolae of which mostly smaller on sides and crests of primary ridges and larger within enclosures; proximal face only slightly rounded to flattish or even somewhat hollowed, generally with very irregularly contorted, closely drawn together, reticulated ridges separated by narrow fissures (Figure 2B); at juncture of proximal and distal faces, when seen from inner face, encircling row of reticulated primary ridges on distal face projecting beyond rim of smaller proximal face, appear to form an undulating wing, \pm 10 μ m wide. *Elaters* yellowish brown, not tapering but sometimes branched, doubly spiral (Figure 2C), up to 290 \times 12.5 μ m. *Chromosome number*: $n = 9$ (Bornefeld 1987).

DISCUSSION

In the family Targioniaceae, two subfamilies, Targionioidae and Cyathodioidae Grolle, are recognized, each with only a single genus. They are characterized by gynoecea that become ventrally displaced at the apex of the thallus and capsules which are enclosed in a bivalved, mussel-shaped involucre.

In *Targionia* species the thalli are compact and somewhat leathery, with low air chambers containing chlorophyllose filaments and a thick layer of storage tissue below; in *Cyathodium* species the thalli are delicate, with tall air chambers lacking chlorophyllose filaments and with much reduced storage tissue.

To date, no monographic studies have been done on the genus *Targionia*, although as many as 26 names have been recorded under it (Geissler & Bischler 1990). Piippo (1991), however, recently speculated that most of these names will undoubtedly prove to be synonyms of *T. hypophylla*. There are at least two other *Targionia* species with well-defined specific limits, namely *T. stellaris* (K. Müll.) Hässel de Menéndez (1963) from Argentina and a new species from India reported by Udar & Gupta (1983).

Targionia hypophylla, the only representative of the genus, is a widespread, almost cosmopolitan species [for total range see Piippo (1991)], occurring especially in temperate and seasonally dry areas where it grows as a xero-

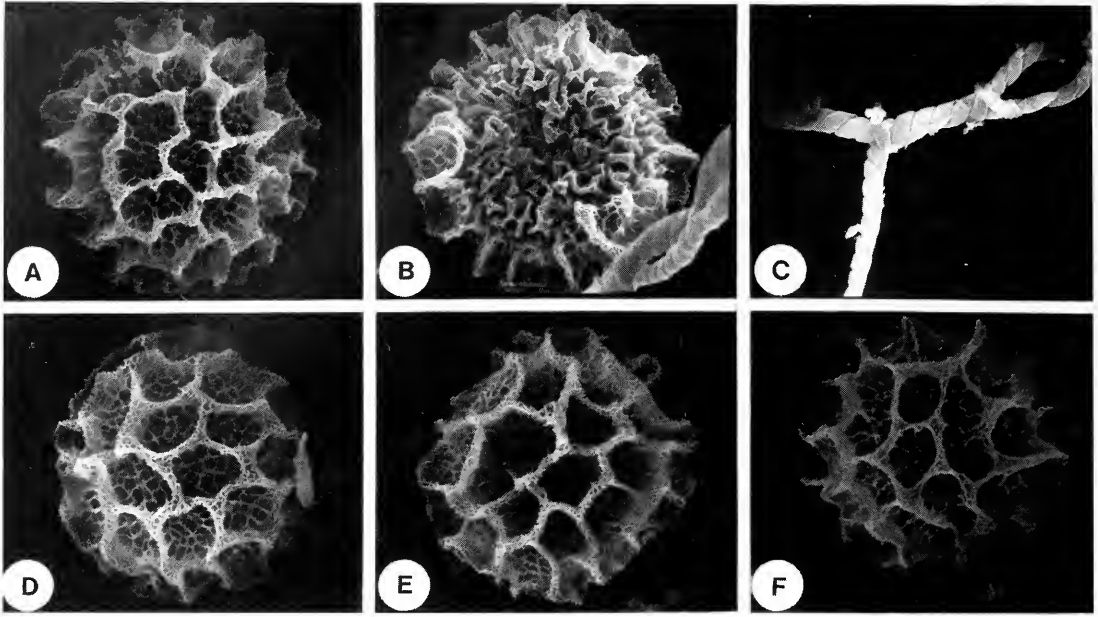


FIGURE 2.—*Targionia hypophylla*. SEM micrographs of spores and an elater. A, D–F, distal face of spore; B, proximal face of spore; C, elater. A–C, *S.M. Perold* 2365; D, *Koekemoer* 433; E, *Garside* 6573 (Round House); F, *Schelte* 4947. A, $\times 500$; B, $\times 530$; C, $\times 490$; D, $\times 445$; E, $\times 560$; F, $\times 460$.

phyte on soil in rock crevices, on soil over rock outcrops or under rock overhangs, or as a pioneer on disturbed earth banks, like road cuttings. Sometimes other liverworts such as *Riccia* spp., *Plagiochasma* spp., or *Mannia* spp. are also present.

Targionia hypophylla is easily recognised, when fertile, by the ventrally displaced capsule contained in a shiny black pouch at the apex, by which further lengthening of the branches is arrested. Sterile plants are distinguished by their dark green, somewhat leathery appearance, the conspicuous white-encircled air pores and reddish to purple-black triangular ventral scales with a single appendage. Kashyap (1914) regards it as a very variable species, and so does Schuster (1992), who thinks that incipient speciation is under way; on the other hand Müller (1951–1958) observes that, in spite of its wide distribution, plants display little variation and the species is probably very old. It is somewhat similar to *Mannia* spp., but these differ from it by their less conspicuous air pores and by capsules borne aloft on a longish stalk. *Plagiochasma* spp. have smaller air pores and more pronounced spicules on the dorsal epidermal cells, with the capsules also raised on a stalk.

T. hypophylla was previously described from southern Africa by Sim (1926) and Arnell (1963). It has been quite rarely collected in Namibia (from whence Volk (1979) recorded 14 collections), central Transvaal, Natal, Orange Free State, Lesotho, Transkei, central, southern and eastern Cape, but frequently in the winter rainfall areas of the northwestern and southwestern Cape (Figure 4).

Further north in Africa it has also been recorded from Ghana by Jones & Harrington (1983), Tanzania (Bizot *et al.*

1978), Kenya and again Tanzania (Bizot *et al.* 1985), Malawi (*S.M. Perold* 2665 PRE), Zambia (Vanden Berghen 1972), Zimbabwe (Sim 1926; Best 1990) and the adjacent islands of Madagascar (Arnell 1963) and Réunion (Bischler 1990), although in the latter report, it is listed as *T. hypophylla* and in brackets, 'or *T. lorbeeriana*'. Frey & Kürschner (1988) report *T. hypophylla* from the Arabian Peninsula (together with *T. lorbeeriana*) as well as a possible new morphotype, *T. hypophylla* spp. *linealis* (spp. *nova*?). *T. elongata* is also known from Africa (Ethiopia), and Scott & Pike (1988) have published SEM micrographs of its spores, which are very distinct and clearly different from those of *T. hypophylla*, in that there are only 5 or 6 large, \pm smooth areas on the distal face, as opposed to the usual 16 or 17 reticulated ones in *T. hypophylla*. On a recent visit to Malawi, some specimens of *Targionia* were collected, one of which, *S.M. Perold* 2653, had up to 30 reticulated areas (Figure 3F), 7.5–10.0 μm wide, on the distal face; the spore diameters were 65–72 μm . It is not certain, however, whether we are dealing with a different species or not.

Targionia hypophylla L. var. *fimbriata* K. Müller is not treated as a distinct variety in this study of southern African specimens as was done by Arnell (1963), because the presence of fimbria along the ventral scale margins is very variable, even in thalli from the same population. Apical scales are also more frequently fimbriate than older ventral scales on the same branch. Schuster (1992) regards the intrapopulational variation in this feature as so great that no taxonomic segregation of the two extremes seems possible to him.

Statistical and other studies by several authors (Sérgio & Queiroz Lopes 1972; Zamora *et al.* 1990; Jovet-Ast

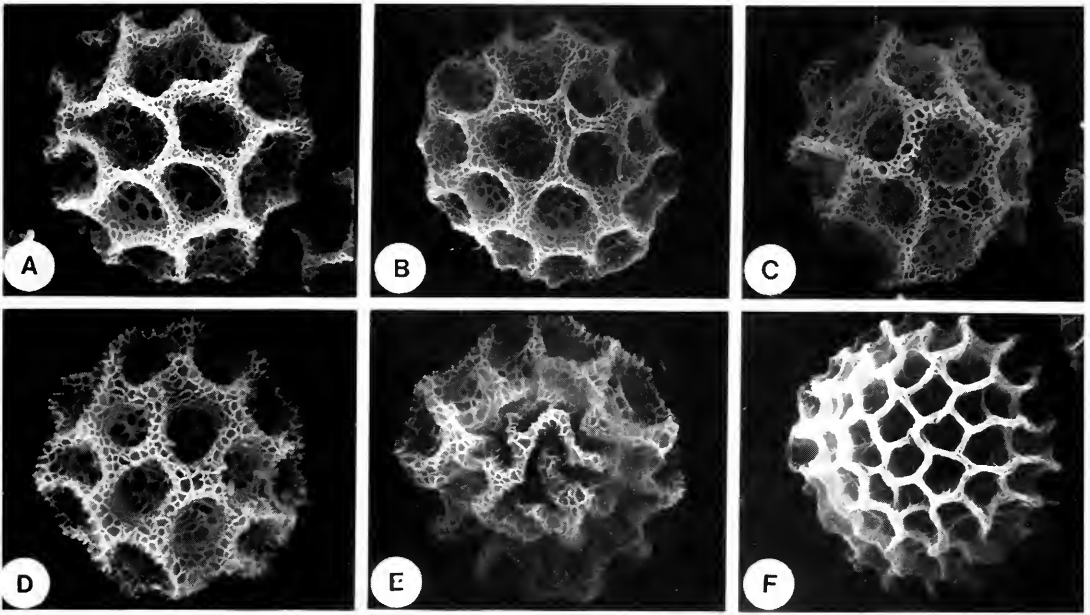


FIGURE 3.—*Targionia* spp. SEM micrographs of spores. A–E, *T. lorbeeriana*: A–D, distal face; E, proximal face. F, distal face of *T. sp. A*, Sérgio & Sim-Sim Lev. 70; B, Cros *et al.* 12-VII-1984; C, Sérgio 148161; D, E, S. Arnell s.n. (Tenerife); F, S.M. Perold 2653 (Malawi). A, $\times 550$; B, $\times 490$; C, $\times 635$; D, E, $\times 580$; F, $\times 620$.

1956; Jovet-Ast & Zigliara 1967 and Zigliara 1970) have confirmed the existence of an allied species, *T. lorbeeriana* (Müller 1940) of which I have studied the type specimen (leg. Huber-Tharandl, (5) collected in Sicily). Arnell (1963) and Magill & Schelpe (1979) record the presence of *T. lorbeeriana* in southern Africa, but this could not be confirmed in the present investigation although (Arnell (1963) even records *T. lorbeeriana* var. *fimbriata* from here). The specimens which Arnell placed under *T. lorbeeriana*, Garside 6573 [spore diameter 57.5–62.5 μm (Figure 2E)] and Schelpe 4947 [spore diameter 75–85 μm (Figure 2F)] are undoubtedly *T. hypophylla*, judging by their spore ornamentation and cell measurements of the thalli and scales. The correct naming of old dried herbarium material is, however, difficult, since the colour of the thalli fades, as does the distinctive odour of *T. lorbeeriana*. Spore ornamentation (see later) seems to be a more reliable and certainly more permanent distinguishing character. Grolle (1983) regards reports of the occurrence of *T. lorbeeriana* in the East African Chyulu Mountains (Bizot *et al.* 1978), as well as in the Cape (and India), as needing verification. *Targionia lorbeeriana* is thought to be a 'triploid race' of *T. hypophylla*, as it has 27 chromosomes. It is said to be characterized by a strong smell of acid pear drops when fresh; by the cordate shape and light green colour of the thallus; by larger, oval air pores and by different cell dimensions [for the latter see Zamora *et al.* (1990)]. Schier (1974) reports slight differences in the flavonoids of the two species. Differences in the spore ornamentation of the two species were demonstrated by Jovet-Ast & Zigliara (1967). Scott & Pike (1988) consider the spore sculpturing as the clearest and least ambiguous way of separating the two species: in their Australian material they consistently found that *T. hypophylla* has regular areolae, whereas in *T. lorbeeriana* the areolae are irregular in arrangement.

Spore samples of 20 different specimens of *T. lorbeeriana* (on loan from European herbaria) were presently studied with the SEM and compared with more than 40 spore samples of local *T. hypophylla*. In *T. lorbeeriana* spores there are fewer ridges on the proximal face (Figure 3E) and on the distal face, the fine reticulum, particularly that covering the inside of the polygonal areas of the coarse reticulum, has thicker walls (Figure 3A–D); the proximal spore face in *T. hypophylla* has numerous contorted ridges and the walls on the distal face are thin and the areolae oval or irregular in shape and size, the fine mesh presenting an altogether 'looser' appearance (Figure 2A, D–F). Of the southern African material examined, spore ornamentation of Magill 6606, Van Rooy 2973, 3142a seems to be intermediate between *T. hypophylla* and *T. lorbeeriana*. Judging by my findings, the illustrations by Scott &

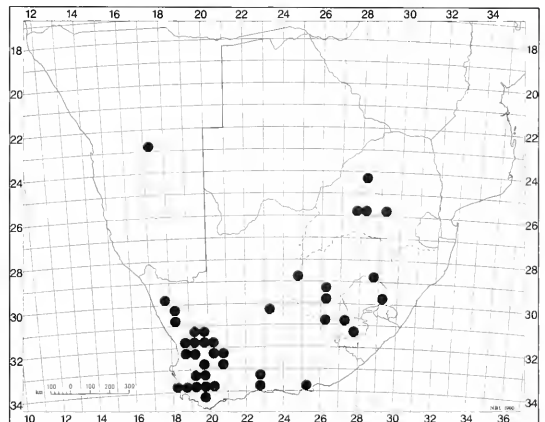


FIGURE 4.—Distribution of *Targionia hypophylla* in southern Africa.

Pike (1988: plate 1.1), appear to be of *T. lorbeeriana* and 1.2 of *T. hypophylla*, in other words, the reverse of what they are stated to be. The *T. hypophylla* spores illustrated by Taylor *et al.* (1974) are closely similar to those in my study.

Cyathodium foetidissimum Schiffner

Arnell (1963) observed that a specimen in the National Herbarium, Pretoria, collected by A.V. Duthie at Belvedere, Knysna, probably belongs to this species, i.e. *Cyathodium foetidissimum*. This specimen has been examined and its spores photographed. It is undoubtedly a species of *Riccia* and the ornamentation of the spores proves it to be *R. rubricollis* Garside & Duthie ex Perold (Perold 1991). On the small specimen packet inside the larger envelope, in Sim's handwriting is the note 'Miss Duthie's (No. 23) new *Riccia*, Belvedere, Aug. 1928' and below it, in Arnell's writing and signed by him is the annotation '*Cyathodium* sp.'. One wonders why Arnell had ignored Sim's identification, as the latter must have received the specimen from Duthie herself. In mitigation, it may be added though, that the material had been pressed and it is only a small sample, perhaps even a little atypical, but the internal sporangia and spores immediately place it correctly.

The other two species of *Cyathodium*, *C. africanum* and *C. aureonitens* which Arnell (1963) thought would possibly be found in southern Africa, have so far not been collected here and it is doubtful if they ever will be, since they are conspicuous and luminous green, and it is unlikely that they could have been overlooked. The presence of the genus, *Cyathodium* in southern Africa has therefore not been confirmed although it is very widely distributed in the rest of Africa (Jones 1952).

SPECIMENS EXAMINED

NAMIBIA.—2217 (Windhoek): Dassieskuppe, Ostseite, an schattigen Felsen, in Moosgesellschaft, (–CB), *Volk 11357* (M, PRE).

TRANSVAAL.—2428 (Nylstroom): Waterberg Game Park along Melk River, shady riverbank, (–AB), *Leistner 3558* (PRE). 2527 (Rustenburg): Swartkop Picnic Resort, near Randburg, on steep earth bank above stream, (–DD), *S.M. Perold 249* (PRE). 2528 (Pretoria): Pretoria, along Apies River, (–CA), *Scott 23* (PRE). 2529 (Witbank): Witbank, C.R. Swart Nat. Res., at subsidiary stream entering Olifants River from west, on streambed, clay soil, (–CD), *Glen 1475* (PRE).

NATAL.—2828 (Bethlehem): Drakensberg, Royal Natal Nat. Park, Broome Hill, in forest, (–DB), *Cholnoky 182* (BOL); Drakensberg, lower western slopes of Sentinel along footpath to chain ladder, alpine heath/grassland with igneous rock outcrops, (–DB), *Magill 6606* (PRE). 2929 (Underberg): Sani Pass Hotel, opposite bank of Mkhomazana River, at waterfall, on soil, (–CB), *S.M. Perold 2509* (PRE); halfway up Sani Pass, vertical rock wall, with earth pockets, on soil, (–CB), *S.M. Perold 2517* (PRE).

O.F.S.—2926 (Bloemfontein): Bloemfontein, Eagle's Nest, (–AA), *Potts CH 1143* (PRE); Bloemfontein, (–AA), *T.R. Sim CH 1137* (PRE); Farm Lastpoort on the Ruigtespruit, between Reddersburg and Helvetia, grassland with trees and shrubs, on soil, (–DC), *Van Rooy 2345* (PRE).

LESOTHO.—2828 (Bethlehem): 5 km from New Oxbow Lodge to Mokhotlong, waterfall over basalt cliff in tributary of Fanana River, near Maluti Club Ski Chalet, alpine heath-grassland, S aspect, on soil in sheltered rock crevice, (–DC), *Van Rooy 2961, 2973* (PRE); 6 km from New Oxbow Lodge to Mokhotlong, alpine heath-grassland, on soil over basalt, (–DC), *Van Rooy 3058* (PRE); 4 km from New Oxbow Lodge to Butha Buthe, alpine heath-grassland, on soil bank at flattish basalt outcrops, NW aspect, (–DC), *Van Rooy 3142a* (PRE). 2929 (Underberg):

Kotisephola Pass, between Sani Top and Mokhotlong, alpine heath-grassland, basalt outcrops at top of pass, rock overhang, (–CA), *Van Rooy 3399* (PRE); Sani River banks, ± 7 km from Sani Top, along road to Mokhotlong, alpine heath-grassland, on soil in rock crevice, (–CA), *Van Rooy 3461*; Sani Top, mountain slopes, W of Border Post, alpine heath-grassland, on soil, (–CB), *Van Rooy 3554* (PRE).

TRANSKEI.—3127 (Lady Frere): near top of Cala Pass, moist vertical bank in road cutting, (–BC), *Glen 1718* (PRE).

CAPE.—2824 (Kimberley): Kimberley, (–DB), *Welman CH 1141* (PRE). 2917 (Springbok): in valley leading from Ookiep to 'Ropeway', damp corners under ledges, (–DB), *Giffen CH 1136* (PRE). 3018 (Kamiesberg): Inkruip, northern Khamiesberg, south slopes, damp ground in lee of large granite boulders, (–AA), *Oliver 7220* (PRE); Sors Sors area, NE of Kamieskroon, (–AA), *Oliver 9206* (PRE); 19 km NE of Kamieskroon, 5 km after turnoff on road to Rooifontein, (–AA), *S.M. Perold 1473* (PRE); 2 km beyond Willem Stone Bridge, Pedroskloof, on road to Rooifontein, on soil under rock, (–AA), *S.M. Perold 1496* (PRE); 3 km along Rooifontein road, after turnoff from Kamieskroon-Leliefontein road, on soil beneath rock overhang, (–AA), *S.M. Perold 2138* (PRE); 5.2 km along Rooifontein road, after turnoff from Kamieskroon-Leliefontein road, (–AA), *S.M. Perold 2169* (PRE); southern Khamiesberg, Klipport, SE of Hoedberg, granite hill, slope facing south, sandy hollows, (–CB), *Oliver 9557* (PRE). 3023 (Britstown): Britstown, Farm Jakkalskuile, (–AD), *Viljoen CH 4523* (PRE). 3026 (Aliwal North): Albert Dist., ± 12 km SE of Bethulie, Cliftonvale Farm, foot of rocky cliffs, seepage zone, (–CA), *H.H. Burrows 2522* (PRE). 3027 (Lady Grey): Dist. Herschel, Sterkspruit, (–CA), *Hepburn CH 1138, CH 1139* (PRE); Witteberg Mts, Joubert's Pass, 8 km east of Lady Grey, western aspect, alpine heath-grassland, on soil, (–CB), *Van Rooy 2700* (PRE). 3118 (Vanrhynsdorp): Gifberg, SE of Van Rhynsdorp, at top of mountain, underneath rock, drier area away from stream, (–DC), *S.M. Perold 2754* (PRE). 3119 (Calvinia): Van Rhyns Pass, at top of plateau, on soil, (–AC), *S.M. Perold 2186* (PRE); Hantamsberge, top of mountain near FM tower, mountain rethosterveld, rock and soil pockets, (–BD), *Koekemoer 822* (PRE); south side of Hantams Mountain, near FM tower, on soil between rocks, (–BD), *S.M. Perold 1824* (PRE); Farm Daantjie-se-kraal, 37 km along road between Soetwater and Clanwilliam, 8 km before Botterkloof Pass, (–CB/CD), *S.M. Perold 1871* (PRE); Vondelingsfontein, northern Roggeveld, damp ground in lee of shrubs, (–DD), *Oliver 8911* (PRE); Vondelingsfontein Farm, 10 km from Calvinia on road to Middelpas, along small streamlets at roadside, (–DD), *S.M. Perold 1839* (PRE). 3120 (Williston): northern Roggeveld, Knechtsbank, kloof north of farm, south slopes with dense rethosterbos scrub, (–CC), *Oliver 8920* (PRE). 3218 (Clanwilliam): middle slopes of Pakhuis Pass, on Clanwilliam side, (–BB), *Koekemoer 433* (PRE); Aggensbachsberge, ground forest, (–BB), *Stirton 9280* (PRE); 20 km N of Citrusdal, past Hexriver Farm, on rocky outcrops at roadside, above Olifantsrivier, (–BD), *S.M. Perold 530* (PRE); 5 km along road to Algeria, after turnoff from Cedarberg road, under damp overhang near road, (–BD), *S.M. Perold 2351* (PRE). 3219 (Wuppertal): 3 km before turnoff to Biedouw/Wuppertal, on R364, between Soetwater and Clanwilliam, at streamlet, on sand over sandstone, (–AA), *S.M. Perold 1883* (PRE); 4 km south of Algeria Forest Station, (–AC), *S.M. Perold 2365* (PRE); Ceres, Kaggakamma Nat. Res., near beacon 3 in streambed, at foot of boulders, (–DA), *Koekemoer 768, 769, 770* (PRE). 3220 (Sutherland): 24 km NW from Sutherland (Roggeveld Mtns), occasional in S aspect rock crevices, (–AB) *Schelpé 4952* (BOL); 2 mls N from Sutherland, occasional on S aspect rock edges under bushes, (–BC), *Schelpé 4947* (BOL); Verlaten Kloof, 18 mls S from Sutherland, locally frequent under asparagus bushes on S aspect, shale slope, (–DA), *Schelpé 4942* (BOL); Sutherland, near top of Komsberg Pass, in rethosterveld, on sandy-loamy soil, (–DB), *Vlok 2667* (PRE); Smoushoogte, Klein Roggeveld, damp southern slope, with short rethosterbos scrub, (–DC), *Oliver 8969* (PRE). 3318 (Cape Town): Peninsula, Constantia slopes, (–CD), *S. Arnell 379* (BOL); Kirstenbosch, (–CD), *S. Arnell 565* (BOL); Cave Peak (–CD), *S. Arnell 615* (BOL); Lion's Head, Round House, (–CD), *S. Arnell 1176* (PRE); behind Round House, Camps Bay, on granite soil, (–CD), *Garside 6495* (BOL); Round House, Camps Bay, on soil, (–CD), *Garside 6573* (BOL); Camps Bay, below Round House, (–CD), *Garside 6674* (BOL); Table Mountain, Slongoli, (–CD), *T.R. Sim CH 1149* (PRE); Devil's Peak, (–CD), *T.R. Sim CH 1142* (PRE); Cape Town, (–CD), *H.A. Wager CH 1133* (PRE); Stellenbosch Flats, (–DD), *Duthie CH 1148* (PRE); Stellenbosch, (–DD), *Duthie CH 1147* (PRE); Jonkershoek road, Stellenbosch, earth bank by side of road, (–DD), *Garside H60* (BOL); Jonkershoek, Stellenbosch, (–DD), *Garside 9* (PRE). 3319 (Worcester): Gydo Pass, on soil, (–AB), *Stirton 9160* (PRE); Hex River Pass road, occasional on shaded earthbank in dry stream bank, (–BD), *Schelpé 4918* (BOL); Hex River Pass, near summit, gully, on damp ground, (–BD), *Stirton 9482* (PRE); Bainskloof,

NE of Wellington, vertical rock wall at roadside, on soil, (–CA), *S.M. Perold* 2785 (PRE); Worcester Karoo Garden, amongst karoid shrubs, (–CB), *Koekemoer* 364 (PRE); Farm Leipzig, east of Worcester, at foot of Rabiesberg, on soil on rock face, (–DA), *Morley* 289 (PRE); Sandhills, north of Worcester, near railway line, on soil on rock outcrop, (–DA), *S.M. Perold* 579 (PRE). **3320** (Montagu): Montagu, Bath Kloof, (–CC), *S. Arnell* 749, 758 (BOL). **3322** (Oudtshoorn): Prince Albert, at northern base of Swartberg Pass, in arid mountain fynbos, on loamy sandy soil, (–AC), *Vlok* 2660 (PRE); Meirings Poort, North of De Rust, near Oudtshoorn, on earth bank above road, (–BC), *S.M. Perold* 898 (PRE); near Hoekplaas, on gravel road from De Rust to Unionsdale, on rocky slope under karoo bushes, (–DB), *Koekemoer* 477a (PRE). **3325** (Port Elizabeth): Hells Gate, Uitenhage, (–CD), *T.R. Sim* CH 1140 (PRE). **3419** (Caledon): Greyton Kloof; on soil on rock wall next to footpath, (–BA), *S.M. Perold* 607, 1170 (PRE); Betty's Bay, (–BD), *S. Arnell* 695 (BOL).

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The hepatic, *Jensenia spinosa* (= *Pallavicinia stephanii*: Pallaviciniaceae), in southern Africa

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Keywords: hepatic, *Jensenia spinosa*, Metzgeriales, Pallaviciniaceae, *Pallavicinia stephanii*, Pallavicinioideae, southern Africa

ABSTRACT

Recently, specimens of *Jensenia spinosa* (= *Pallavicinia stephanii*) were collected at the type locality 'Spitskop, bei Lydenburg', in the Transvaal. The type, which previously was the only specimen from southern Africa, is held at G. A detailed description of *J. spinosa*, illustrated with photographs of the thalli and spores is presented here, since earlier descriptions are sketchy and lack illustrations.

UITTREKSEL

Onlangs is eksemplare van *Jensenia spinosa* (= *Pallavicinia stephanii*) by die tipelokaliteit, 'Spitskop, bei Lydenburg' in Transvaal versamel. Die tipe, wat voorheen die enigste eksemplaar vanaf Suider-Afrika was, word by G gehou. 'n Beskrywing van *J. spinosa*, geïllustreer met foto's van die tallusse en spore word gegee, aangesien vroeëre beskrywings onvolledig en sonder illustrasies is.

INTRODUCTION

The subfamily Pallavicinioideae (Migula) Grolle of the family Pallaviciniaceae Migula, order Metzgeriales, comprises the genera *Pallavicinia* and *Jensenia* (see below). *Jensenia* Lindb. (1868) is the older name for the latter of the two genera and had to replace *Makednothallus* Verdoorn (1932) (Grolle 1964), which was based on *Mittenia* Gott. (1864). This name, however, was taken up already by *Mittenia* Lindb. (1863), a genus of mosses. *Jensenia* was treated by Schiffner (1893) and later authors such as Schuster & Inoue (1975); Grolle (1984); Grolle & Piippo (1984) and Schuster (1992), not as a genus, but as a subgenus of *Pallavicinia*. It corresponds to Stephani's (1900) *Pallavicinia* sectio *Dendroideae*. Differences between *Jensenia* and *Pallavicinia* are shown in Table 1.

Grolle & Piippo (1986) list several of the above differences to demonstrate that *Jensenia* is a natural group which they prefer to treat at the generic level. I have followed them in this study even though Schuster (1992) adopts a broadened concept of *Pallavicinia* to include *Jensenia* because of the following: in *Pallavicinia levieri* Schiffn. the androecia have scales scattered over the costal surface in several poorly demarcated rows, i.e. more like those in *Jensenia* (or *Mittenia*, as Schuster prefers to call it, since *Mittenia* has priority at subgeneric rank). Furthermore, in the Japanese *Pallavicinia longispina* Steph., Schuster (1992) often found a basal stipe that was creeping and rhizoidal, contrasted to an ascending (but not erect) frond, that was 1 or 2 (very rarely 3) times dichotomous, i.e. also as in *Jensenia*, as opposed to *Pallavicinia* which is supposedly always prostrate and without a creeping rhizome. The differences between *Pallavicinia* and *Jensenia* are therefore not clear-cut in the above two characters, but in the remaining ones (see Table 1), the differences are deemed to be sufficiently marked to treat *Jensenia* as

a separate genus, rather than as a subgenus of *Pallavicinia*. Six species (Grolle 1964) or seven (Engel 1990), are classified in *Jensenia*, which belongs to a southern and probably Gondwanaland element. *Jensenia spinosa* (= *Pallavicinia stephanii*; = *Makednothallus stephanii*) is the only African representative. Initially Grolle (1965) had not recognized the combination *Makednothallus stephanii* (Jack) Schust. (Schuster 1963) and Jones (1990) made the combination *Jensenia stephanii* (Jack) Jones. The type specimen of *Pallavicinia stephanii* was collected by Wilms at Spitskop, 'bei Lydenburg', Transvaal, in 1888. This collection is held at G. No specimens of *J. spinosa* were housed at PRE, except for the recent acquisition of a De Sloover collection from Rwanda, through the kindness of Dr Riclef Grolle. Arnell (1963) admits that he did not see examples of this taxon himself, but based his description on that of Stephani. Two recent attempts were made to collect this species again at a locality called Spitskop, situated south of Lydenburg, but were unsuccessful. Only upon coming across a copy of Wilms's (1898) 'Ein botanischer Ausflug ins Boerenland' did it become clear that the Spitskop to which he referred, lay about 50 km east of Lydenburg and 9 km south of the present town of Sabie, which was only proclaimed later. Fresh material of this locally scarce species was recently collected within sight of this Spitskop, on the protected vertical banks of a small streamlet, close to the water surface. *Jensenia spinosa* and its spores are herewith described in detail and illustrated with photographs, as earlier descriptions are sketchy and not illustrated.

***Jensenia spinosa* (Lindenb. & Gott.) Grolle in Grolle & Piippo in *Acta Botanica Fennica* 133: 65 (1986).**

Synphyogyna spinosa Lindenb. & Gott. in Gott. *et al.*: 786 (1847). *Pallavicinia spinosa* (Lindenb. & Gott.) Grolle: 268 (1979). Type: Mascarenes, Ins. Mauritius, leg. Bory (W, lecto.).

S. serrata Mitten in Melliss: 572 (1875). Type: St Helena, leg. Melliss (NY, holo.)

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TABLE 1.—Comparison of characters of the genera *Jensenia* and *Pallavicinia*

Character	<i>Jensenia</i>	<i>Pallavicinia</i>
Habit of thallus	erect, dendroid, from ascending stipe and horizontal, creeping rhizome; branching regularly 2–4 times	procumbent, expanded from wingless stipe; with few or no furcate terminal branches, mostly intercalary from the ventral side of midrib
Margins of thallus	slime papillae absent, confined to branch apices and occasionally along dorsal surface of upper part of stipe	slime papillae present, not confined to apices
Midrib	broad, indefinite, grading into wings	abruptly grading into wings
Androecial orientation	scattered over and completely covering dorsal costal surface, not 2-ranked	in 2 parallel rows, one on either side of costa, leaving the latter free
Gynoeceal orientation	specific, immediately distal to a bifurcation in lower part of frond	not specific, at intervals along costa
Pseudoperianth	basally connate with calyptra	not basally connate with calyptra
Spore ornamentation	cristate, with numerous irregular ridges	reticulate, with areolae

Pallavicinia stephanii Jack in Steph.: 129 (1892). *Pallavicinius stephanii* Jack in Steph.: 324 (1900). *Makednothallus stephanii* (Jack) Schust.: 292 (1963). *Jensenia stephanii* (Jack) Jones: 15 (1990). Type: Transvaal, Spitskop bei Lydenburg, leg. Wilms G 007994, lecto., selected here; Wilms G 007992, para. [Synonymy mostly fide Grolle (1979)].

Terricolous, on damp soil; thallose, medium-sized, green; shoots erect, dendroid, in crowded tufts, expanded into flabellate aerial fronds; once dichotomously branched (Figure 3C), to several (2–4) times (Figure 1A). *Terminal branches* generally 6 or 7(8), very rarely 11 in older plants, up to 10 mm long and tapering distally; proximal branches 2–5 × 1.0–1.7 mm and 165 µm thick over costa, apices blunt to rounded, entire or slightly notched, bearing 2-celled slime papillae (Figure 2C); central conducting strand visible from above (Figure 1A, B) and bifurcating some distance below separation of branches; margins of wings with small remote teeth in sterile plants, but with prominent spines in male and some female plants, lacking slime papillae, plane to undulate, bilaterally rather gradually expanded. *Stipe* ascending, wingless and unbranched, purplish red, basally bearing some rhizoids, ± 10 × 500 µm, with single strand below, double strand above (Figure 1H). *Rhizome* horizontally creeping, branched, dark brown, embedded in the soil, in section (Figure 1D) cortical cells with outer walls slightly thickened, medullary cells thin-walled, larger, ± 45 µm wide, central strand cells thick-walled, 7.5 µm wide. *Rhizoids* mostly ventral, smooth, brownish, slightly thick-walled, ± 12.5 µm wide. *Wings* with forwardly directed marginal teeth, sometimes curved and projecting at angles of 20°–90°, low and blunt (Figure 1F), or up to (3)4 or 5 cells long, basally 2 to 4 cells wide, tapering to pointed uniseriate apices (Figure 2H); marginal cells from above rectangular or polygonal, 30–52 × 17–25 µm (Figure 1J), laminal cells hexagonal, ± 70 × 30 µm (Figure 1K), epidermal cells above midrib rectangular, 35–47 × 20–22 µm (Figure 1L), all containing up to 9 spindle- or rod-shaped oil bodies, finely granulose (Figure 1I), ± 10 µm long, as well as numerous rounded chloroplasts, 2.5 µm wide; in section wings unistratose along margins for 6–8 cell rows, then 2, soon 3 cell layers deep, grading into thickened costa (Figure 1C, E), parenchymal cells enclosed by chlorophyllose epidermis above and below, colourless and empty, rounded, up to 45 × 45 µm. *Costa* with central conducting strand up to 50 × 50 µm, consisting of a group

of ± 11 thick-walled and elongated, brown, sclerenchymal cells, ± 5 µm wide, surrounded by parenchymal cells (Figure 1C, E, G).

Dioicous. *Androecia* above and lateral to costa, covering dorsal central parts of segments of once or twice dichotomously branched, backwardly arched frond (Figure 2A, B, D), margins of segments undulate, prominently toothed (Figure 2H); *antheridia* numerous, not in distinct rows but crowded together, up to 4 alongside each other, globose (Figure 2D, E), 225 × 200 µm, yellowing with age, in axils of and covered by apically directed, dentate to lacinate scales (Figure 2F, G), the latter imbricate, frequently connate at the bases, turning orange, laciniae up to 400 µm long, apically uniseriate, 3 or 4(6) cell rows wide basally, cells up to 75 × 22 µm. *Gynoecea* single, dorsally situated immediately distal to a bifurcation in lower part of frond, which when young is somewhat funnel-shaped with connivent wings (Figure 3A). *Involucre* cup-like, surrounding a group of archegonia (Figure 3E), basally 4 cell layers thick in transverse section (Figure 3G), otherwise 2- or 3-layered (Figure 3F), 1300 µm high, including laciniae 375 µm long projecting upwards from the mouth, 2750 µm wide when opened up and spread out. *Pseudoperianth* developing inside involucre after fertilization, becoming cylindrical (Figure 3D) and eventually ± 4500 µm long, 3 or 4 cell layers thick, irregularly lacinate at mouth, laciniae up to 330 µm long, uniseriate above, 3 or 4 arising from each basal part, up to 500 × 300 µm, separated from each other by slits, sometimes with 2-celled slime papillae at the base, outer cells hexagonal, ± 70 × 37 µm above, elongating to ± 200 × 37 µm below. *Calyptra* initially enclosing capsule and seta (Figure 3D, K), inserted into mature pseudoperianth and basally fused with it, 2825 × 750 µm, creamish white, at apex old archegonial neck projecting and at sides several unfertilized archegonia (Figure 3K) as well as 4-celled slime papillae, 67 × 15 µm, mostly 2 cell layers thick (Figure 3L), outer cells smaller, 60–75 × 30 µm, irregularly shaped, with sinuous walls. *Capsule* cylindrical, 1050 × 750 µm, brown, containing a mass of spores and elaters without elaterophore, wall bistratose (Figure 3I), with outer cells up to 75 × 20 µm, lacking band-like thickenings (Figure 3H), eventually perforating top of calyptra and carried aloft as seta elongates, dehiscing by 2 slits,

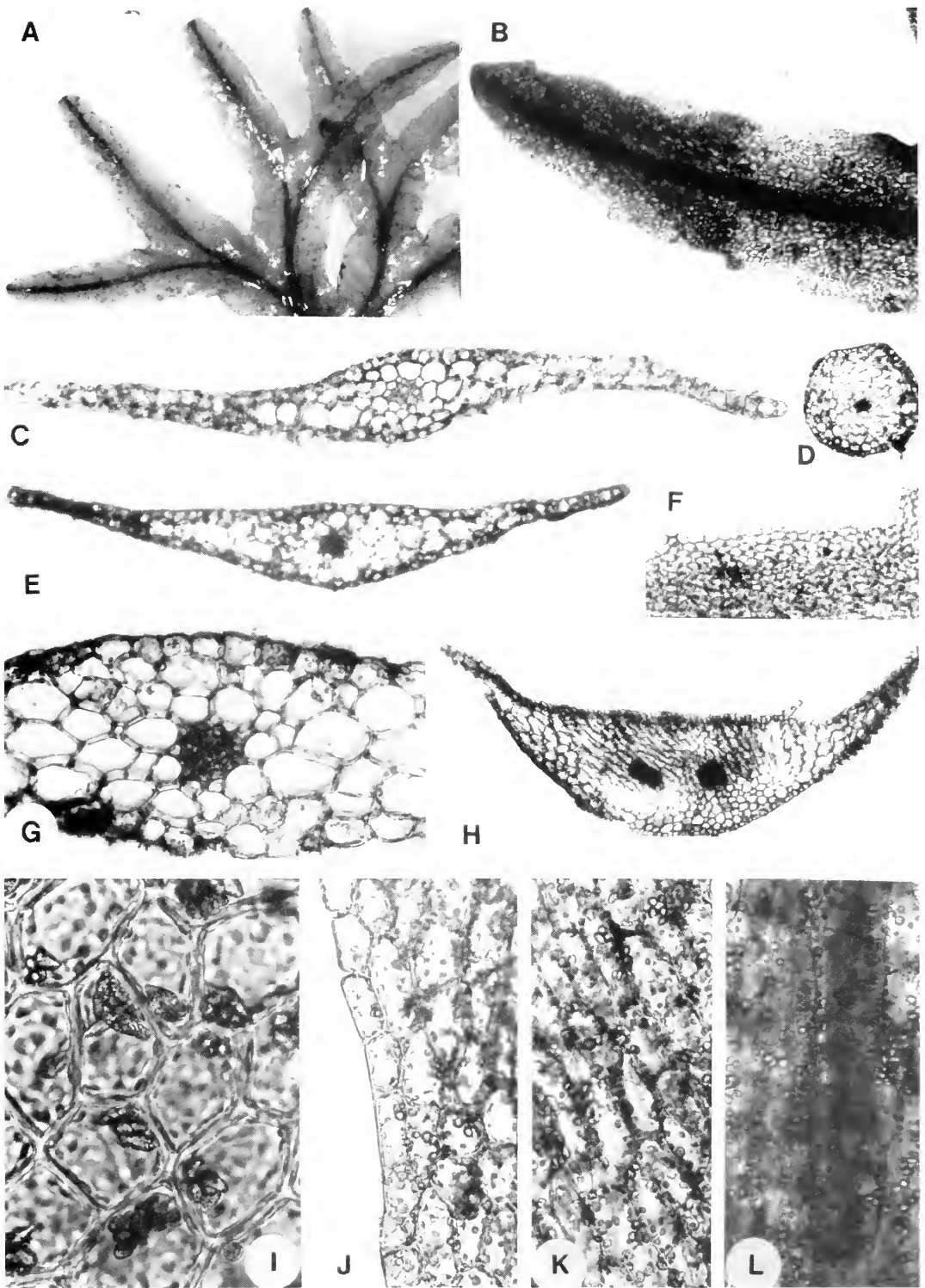


FIGURE 1.—*Jansenia spinosa*: LM photographs of thalli. A, terminal branching; B, single branch with toothed margin; C, ts. of branch showing costa with central strand and lateral wings; D, ts. of rhizome; E, ts. of branch; F, small, remote teeth at margin; G, ts. of costa and central strand; H, ts. of apical part of stipe with double conducting strand, note also 2-celled slime-papillae; I, cells containing oil bodies and chloroplasts; J, cells along margin of branch; K, cells in lamina; L, dorsal cells over costa. A–C, *Wilms 007994*; D–L, *Perold & Koekemoer 2923*. A, $\times 7.5$; B, $\times 25$; C, $\times 125$; D, H, $\times 50$; F, $\times 100$; G, J–L, $\times 250$; I, $\times 500$.

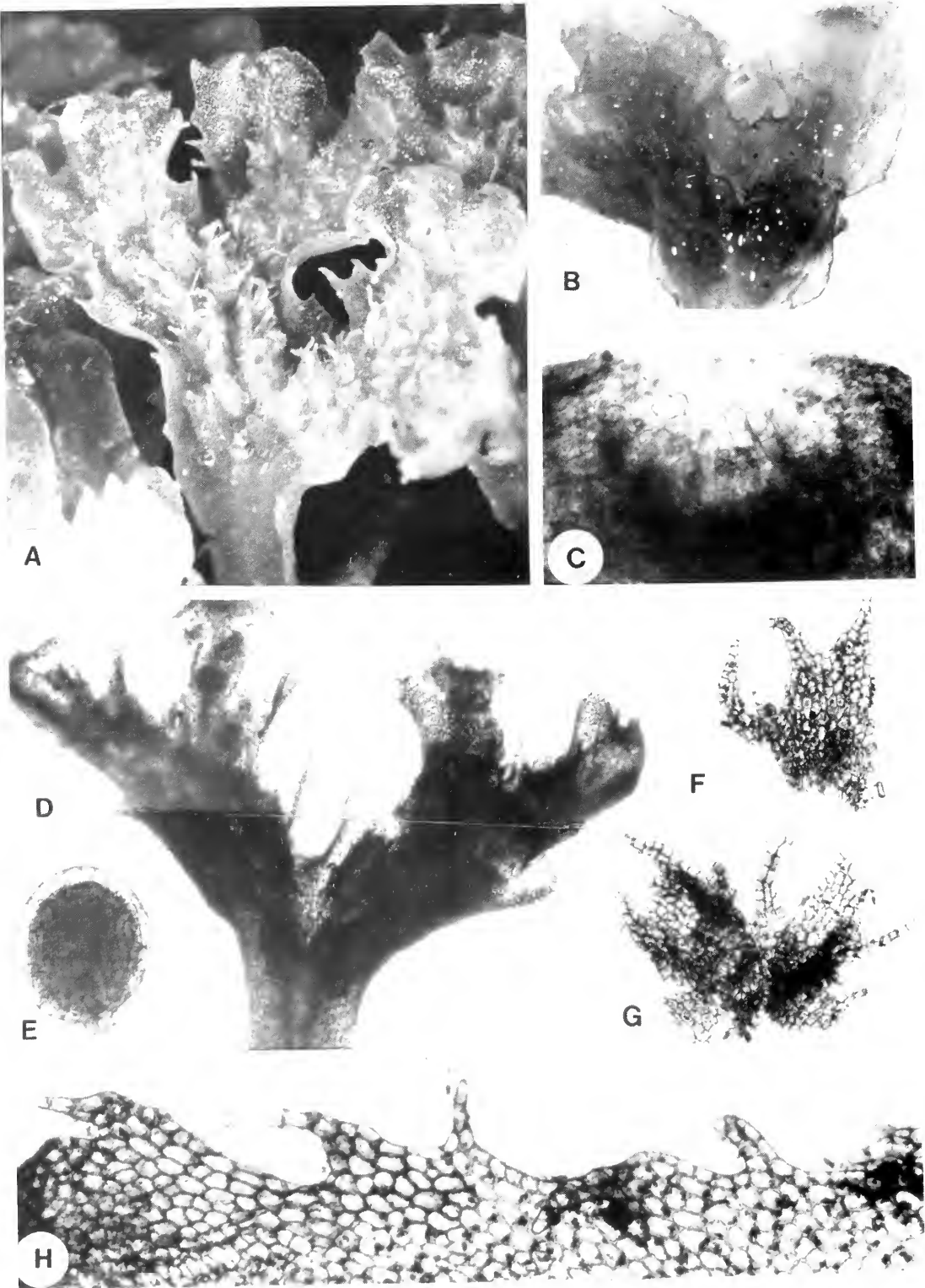


FIGURE 2.—*Jensenia spinosa*, Perold & Koekemoer 2923. LM photographs. A, male thalli with androecia covering costa; B, D, single male plant with androecia; C, two-celled slime papillae at notched apex of thallus; E, antheridium; F, G, scales which cover antheridia (often adjoined at base as in G); H, highly toothed margin of male thallus. A, B, $\times 18$; C, $\times 250$; D, $\times 25$; E, $\times 125$; F, G, $\times 50$; H, $\times 100$.

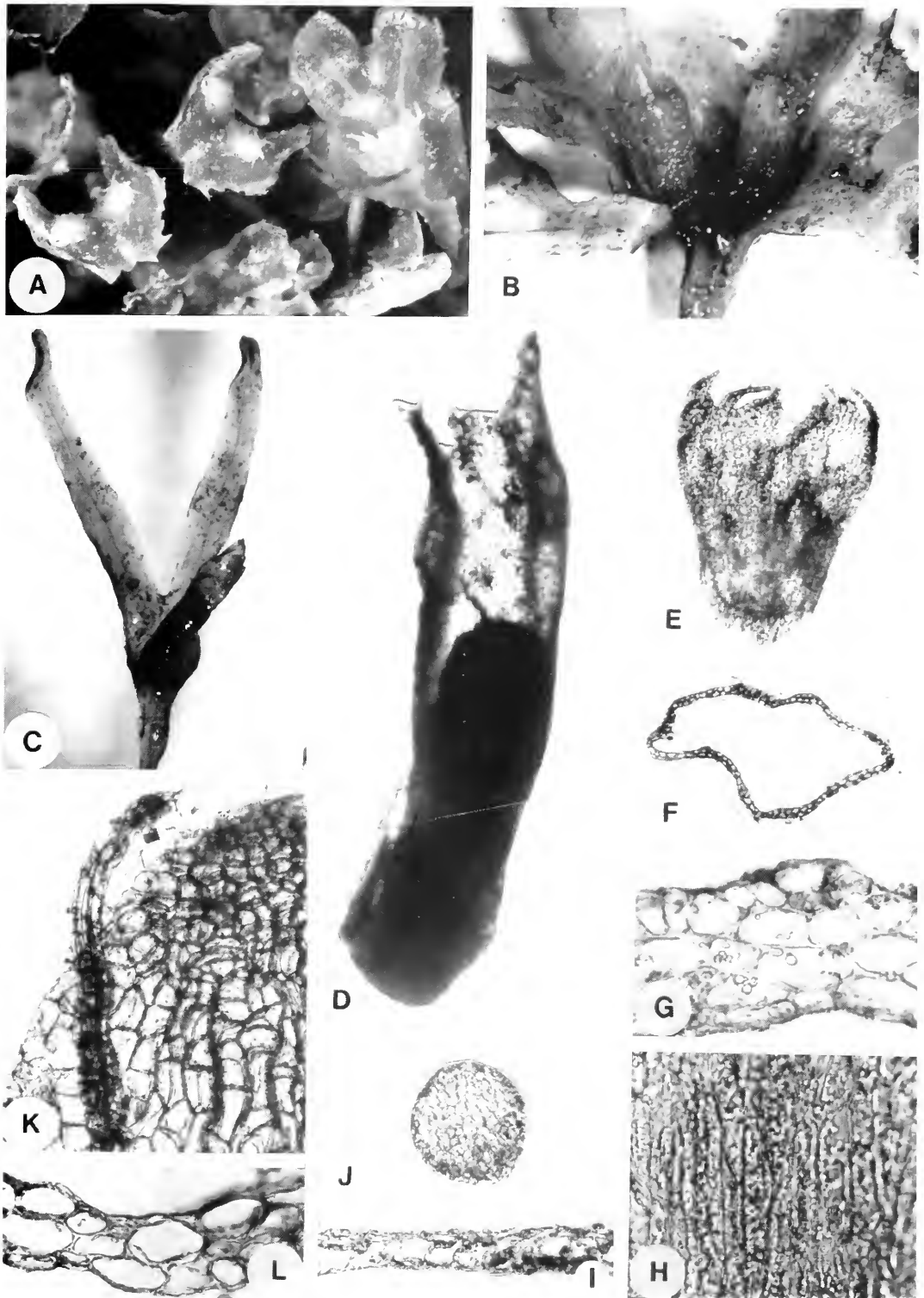


FIGURE 3.—*Jensenia spinosa*: LM photographs. A, female thalli with young gynoecia; B, female thallus with older gynoecia; C, female branch with single gynoecium; D, pseudoperianth opened to show capsule sheathed in calyptra; E, involucre; F, ts. of involucre; G, ts. of base of involucre, 4 cell layers thick; H, capsule wall cells; I, ts. of capsule wall; J, ts. of young seta; K, calyptra wall with unfertilized archegonium still attached; L, ts. of calyptra wall. A–G, *Perold & Koekemoer* 2923; H–L, *De Sloover* 13459. A, C, $\times 10$; B, $\times 12.5$; E, F, $\times 25$; G–I, $\times 250$; J, $\times 50$; K, L, $\times 125$.

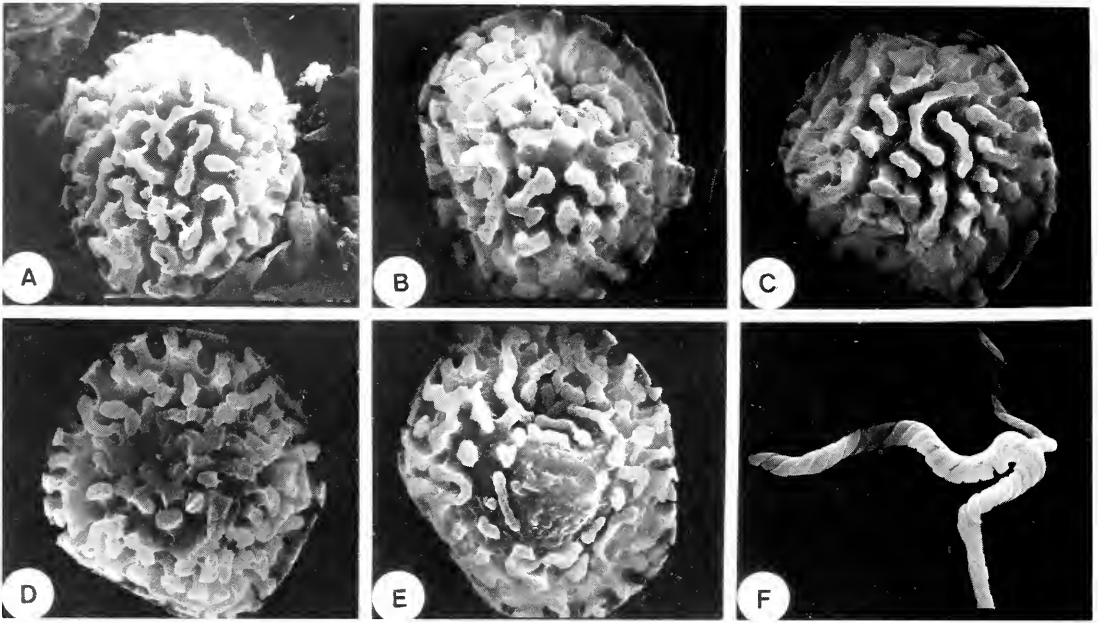


FIGURE 4.—*Jensenia spinosa*: SEM of spores and elater. A–D, distal face of spore; E, proximal face of spore; F, elater. A, Perold & Koekemoer 2923; B–F, De Sloover 13459. A, $\times 1255$; B, $\times 1295$; C, E, $\times 1215$; D, $\times 1193$; F, $\times 375$.

with the valves coherent. *Seta* before elongation and when still enclosed by calyptra, $\pm 875\ \mu\text{m}$ long, diameter in section $450\ \mu\text{m}$, cortical cells $27.5\text{--}37.5 \times 32.5\text{--}37.5\ \mu\text{m}$, in ± 43 cell rows, medullary cells, $30.0\text{--}52.5\ \mu\text{m}$ wide, angular, \pm nine across (Figure 3J); foot $625\ \mu\text{m}$ long, narrowing to a pointed base. *Spores* light brown, globular to oval, $25\text{--}32\ \mu\text{m}$ in diameter, ornamentation cristate with numerous short and long, branched and unbranched, bent or curved ridges (Figure 4A–E), in between with short rods and dots, $2.5\ \mu\text{m}$ high, expanded and flattened on top; proximal face, besides being ornamented as described above, also with a discrete, round area, $\pm 10\ \mu\text{m}$ wide, lacking ridges and with only a few granules visible (Figure 4E). *Elaters* light brown, tapering slightly at ends, up to $290 \times 7.5\ \mu\text{m}$ in the centre, 2-spiral (Figure 4F).

Besides the type locality in southern Africa (Figure 5), *J. spinosa* is known elsewhere in Africa from Malawi, Tanzania, Rwanda and Zaïre, as well as from the islands Mauritius, Réunion and St Helena (Grolle 1979), generally from high elevations. Vána *et al.* (1979) reported it as *Pallavicinia stephanii* from Rwanda and Réunion. It is therefore quite widespread, but scarce.

According to Grolle (1979) *J. spinosa* is very similar to the neotropical species, *J. erythropus* (Gott.) Grolle; Schuster (1992) concludes that in the description and illustrations of *J. erythropus* by Hässel de Menéndez (1961), the scales are scattered over the dilated sectors of the frond segments. The only other dendroid member of the family Pallaviciniaceae in Africa, is *Symphlyogyna podophylla* (Thunb.) Mont. & Necs (Perold 1993) which, in the absence of female material, is quite difficult to distinguish from *J. spinosa*. Grolle (1979) gives a key to distinguish them (on vegetative characters), in which he draws attention to the smaller, as measured by him, $21\text{--}27 \times 24\text{--}35(42)\ \mu\text{m}$, inframarginal cells of the thallus wings

with the cuticle finely punctate to striate in *J. spinosa*, whereas in *S. podophylla* he found these cells to be larger at $50\text{--}60(65) \times 50\text{--}75\ \mu\text{m}$ and the cuticle smooth. Van der Gronde (1980), who studied the genus *Jensenia* in Colombia, states that female material of *Jensenia* is necessary to distinguish it with certainty from a dendroid *Symphlyogyna*, which has a scale-like involucre and lacks a pseudoperianth. In *Jensenia* the involucre is cup-like and, after fertilization, a long pseudoperianth develops; the latter is joined with the calyptra at the base. There are thus three structures surrounding the sporophyte in *Jensenia*: the involucre, the pseudoperianth and the calyptra.

SPECIMENS EXAMINED

RWANDA.—Parc des Volcans, 3 650 m, Vysoke sur pan rocheux (lave), vertical moussu, De Sloover 13459 (ex Herb. Bryologicum R. Grolle).

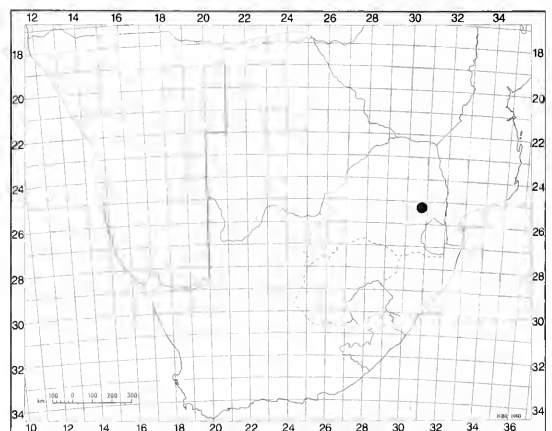


FIGURE 5.—Known distribution of *Jensenia spinosa* in southern Africa.

TRANSVAAL.—2530 (Lydenburg): Spitskop, bei Lydenburg, (–BB), Wilms (G 007992, G 007994); 9 km S of Sabie, 0.5 km N of Spitskop Store, on road R537 from Sabie to White River, at small streamlet on left side of road, on vertical earth bank, (–BB), Perold & Koekemoer 2923 (PRE).

ACKNOWLEDGEMENTS

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Notes on African plants

VARIOUS AUTHORS

VITACEAE

A NEW SPECIES OF *RHOICISSUS* FROM THE TRANSVAAL

Rhoicissus laetans Retief, sp. nov., *R. microphyllae* (Turcz.) Gilg & Brandt similis sed foliis ellipticis vel obovatis, glaucoviridibus, glabris, in sicco valde discoloribus, sine domatiis differt; *R. microphyllae* folia ovata vel elliptica sunt, pilis rufis vestita, cum domatiis fasciculis trichomatorum in axillis venarum principalium lateralium.

Type.—Transvaal, 2430 (Pilgrim's Rest); along Drie Rondawels-Uitkyk road, (–DB), Herman 737 (PRE, holo.). Figure 1.

A shrub, up to 1.5 m high, sometimes scrambling. Tendrils absent. Leaves simple, petiolate; lamina elliptic to obovate, 18–50 × 10–25 mm, glabrous, net-veining prominent on undersurface, margin entire, base obtuse, apex obtuse to slightly acute, very shortly mucronate; stipules absent; petiole up to 5 mm long. Inflorescence a leaf-opposed cyme, tendril-like. Calyx entire. Petals 4, ovate,

2 mm long, yellowish green. Stamens with filaments 1 mm long, dorsifixed, opposite petals, bending over gynoecium. Disc entire, with ovary immersed in it. Style simple, entire, 2 mm long. Stigma not broader than style. Berries 12 mm in diameter. Seed 1–3(–4); testa smooth, dark brown, usually with a prominent, longitudinal furrow.

TRANSVAAL.—2430 (Pilgrim's Rest); Blydepoort Nature Reserve, Lowveld look-out, (–BD), Van Wyk 10233 (PRU); Farm Steenveld 229KT, kranzes overlooking Ohrigstad River, (–DA), Fourie 1316 (PRE); along Drie Rondawels-Uitkyk road, (–DB), Herman 737 (PRE); 18.3 radial miles from Pilgrim's Rest, banks of Blyde River, (–DB), Mogg & Davidson 33547 (J, PRE); Blydepoort Nature Reserve, F.H. Odendaal Rest Camp, (–DB), Van Wyk 5200 (PRE, PRU).

Rhoicissus laetans is endemic to the northeastern Transvaal Escarpment, where it occurs in a small area (Figure 2). The species is found in mountain grassland with stunted shrub vegetation (North-eastern Mountain Sourveld) or on steep, densely wooded kloof slopes with mixed bushveld vegetation. Occasionally it occurs in riverine forest. The species grows on soils derived from quartzite and sandstone. It flowers from at least November (probably earlier, judged by the occurrence of fruits on specimens) till February.

Classification of the new species in the genus *Rhoicissus* is supported by the shape of its flower buds, structure of the floral disc and inflorescence morphology. In *Rhoicissus* the buds are globose in outline (Figure 3). Flower buds of *Cissus* are typically conical to ovoid with the petals cucullate at the apex, whereas those of *Cyclophostemma* are cylindric or flask-shaped, constricted in the middle and inflated at the apex (Figure 3). Flower buds of *Ampelocissus* and *Cayratia* are also globose in

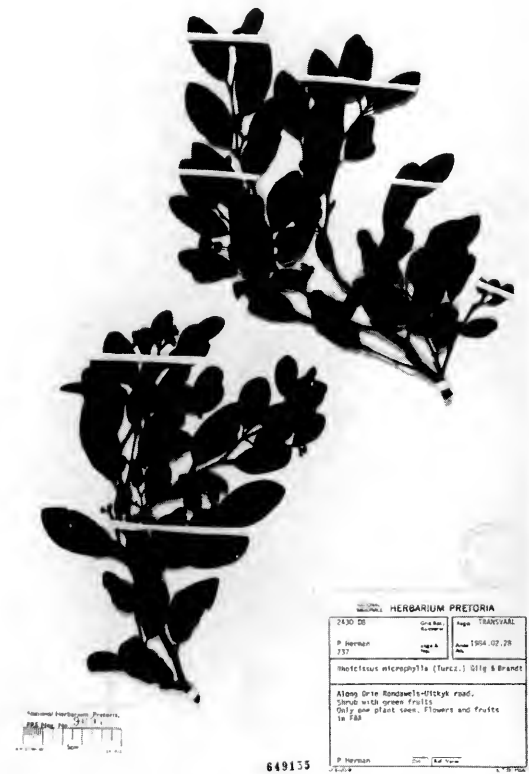


FIGURE 1.—Holotype of *Rhoicissus laetans*, Herman 737 (PRE).

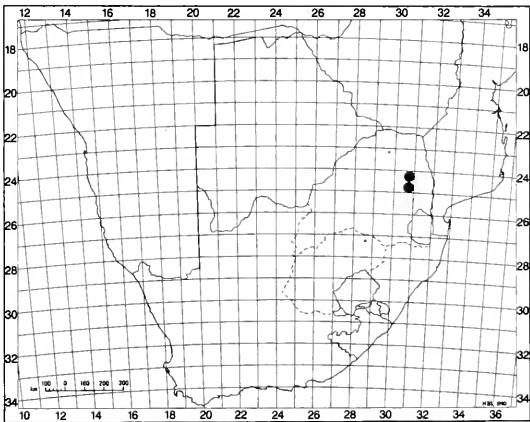


FIGURE 2.—Distribution of *Rhoicissus laetans*.

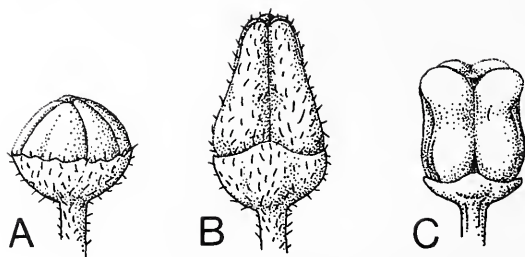


FIGURE 3.—Characteristic flower bud shape in three genera of the Vitaceae: A, *Rhoicissus*; B, *Cissus*; C, *Cyphostemma*.

outline, but *Ampelocissus* differs from *Rhoicissus* in having an inflorescence with tendrils and a floral disc with vertical furrows. *Cayratia* has a thin disc and axillary cymes, whereas in *Rhoicissus* the disc is annular, entire and thick and the inflorescence is a leaf-opposed cyme.

The species of *Rhoicissus* usually have 5 or 6 petals per flower. Although only 4 petals are present in *R. laetans* and *R. microphylla* (as is the case in *Cissus*, *Cyphostemma* and *Cayratia*), the prominent globose flower buds place the species in *Rhoicissus*.

Rhoicissus laetans is distinguished from all the other members of the genus by its shrubby habit and simple, glabrous, glaucous green leaves. In southern Africa *R. tomentosa* (Lam.) Wild & Drummond and *R. microphylla* (Turcz.) Gilg & Brandt also have simple leaves. The leaves of *R. tomentosa* are broadly transversely elliptic to reniform and the species is a high-climbing liane. *R. microphylla*, a small shrub, has ovate leaves with the undersurface of the lamina covered with reddish brown hairs. The other southern African species, namely *R. digitata* (L.f.) Gilg & Brandt, *R. revouilii* Planch., *R. rhomboidea* (E. Mey. ex Harv.) Planch., *R. sessilifolia* Retief and *R. tridentata* (L.f.) Wild & Drummond all have 3-foliolate leaves.

For nearly twenty years it was thought that specimens of *R. laetans* belonged to *R. microphylla*, a species occurring only in the eastern Cape. The two taxa differ not only in their widely disjunct distribution but *R. microphylla* has ovate to elliptic leaves, with reddish hairs and hair-tuft domatia on the undersurface (Figure 4B). *R. laetans*, on the other hand, has elliptic to obovate leaves which are glaucous green and glabrous when fresh (Figure 4A), and prominently discolorous when dried.

The geographical range of *R. laetans* falls within the Wolkberg Centre of endemism, and more specifically the Blyde Subcentre (Matthews *et al.* 1993; listed as *Rhoicissus* sp. nov.). Other woody species endemic/near-endemic to the Blyde Subcentre include *Euclea dewinteri* Retief, *Protea laetans* L.E. Davidson and *Combretum petrophilum* Retief. *Rhoicissus laetans* and its sister species, *R. microphylla*, which occurs in the eastern Cape, mirror a disjunct distribution pattern shown by a number of other Blyde Subcentre endemics, e.g., *Streptocarpus meyeri* B.L. Burt, *Cyrtanthus huttonii* Baker and *Haemanthus paucifolius* Snijman & Van Wyk (Hilliard & Burt 1971; Dyer 1972; Reid & Dyer 1984; Snijman & Van Wyk 1993). The repeated pattern shown by these vicarious taxa should have value for tracing the history and development of the southern African flora.

The specific epithet *laetans* refers to the area from which the species has mainly been collected: Blydepoort Nature Reserve, with 'bly' meaning 'joyful'.

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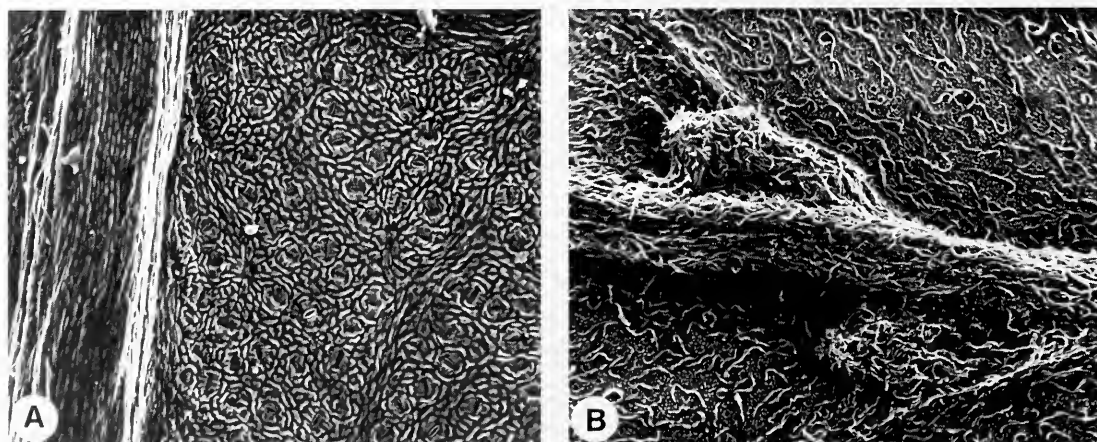


FIGURE 4.—SEM micrograph of leaf undersurface: A, *Rhoicissus laetans*, $\times 35$; B, *R. microphylla*, note scattered trichomes and hair-tuft domatia in axils of principal lateral veins, $\times 16$.

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E. RETIEF

MS. received: 1992-10-19.

CUCURBITACEAE

A NEW SPECIES OF *KEDROSTIS* FROM THE WESTERN CAPE

***Kedrostis psammophila* Bruijns, sp. nov.**, a ceteris speciebus capreolis destitutis, caulibus horizontalibus subterraneis repentibus, receptaculo longissimo in flore femineo cum ovario subterraneo differt. Type: South African Cape, Nortier, *Bruijns* 4569 (BOL, holo.; PRE, K, M, iso.).

Plant with carrot-shaped to cylindrical tuber up to 200 × 100 mm or more, usually at least 150 mm beneath soil surface and pale grey-brown with white flesh, with several smaller subsidiary tubers produced elsewhere along stems, very strongly foetid, monoecious. *Stems* soft, creeping horizontally to 1 m or more and extensively branched beneath soil surface, cylindrical, white; portions above ground usually not more than 150 mm long, clustered, horizontally spreading, bearing leaves along whole length, grey-green, hairy. *Leaves* palmately 3- to 5-lobed often to at least halfway but sometimes ± entire, 6–20 × 10–25 mm, segments irregularly dentate, almost all of equal size, grey-green, hairy on both sides; petiole 8–15 mm long, grooved above, setose. *Tendrils* and *stipules* none. *Flowers* unisexual, male and female quite different and borne separately, inflorescences arising from underground stems. *Male flowers* on *peduncle* ± 80.0 × 1.5–2.0 mm of which usually 50 mm protruding from soil bearing 25 or more flowers, green and pilose above ground, white and glabrous below; *bracts* ± 4 mm long, often with few small teeth on margin, lanceolate, spreading; *pedicel* 12–22 mm long, slightly over 1 mm thick; *calyx* green, pilose outside, receptacle ± 4 mm long; *sepals* 1.5–2.0 × ± 1.5 mm, acute; *corolla lobes* spreading with recurved obtuse tips, 5–7 × 3 mm at base, outside green and pilose, inside green with darker longitudinal stripes, fine hairs, and yellow multicellular short clavate papillae towards edge and apex; *anthers* 3, white, erect, ± 3 mm long, very hairy inside around base, one small with 1 locule, two larger with 2 locules each. *Female flowers* on subterranean *peduncle* 0–20 × 1.0–1.5 mm, bearing 1 flower and 1–2 small bracts at apex, white, glabrous; *pedicel* curving downwards, ± 2 mm thick, white with few scattered hairs; *calyx* pale yellow, sparsely and finely pilose, smooth; *receptacle* initially horizontal then erect, cylindrical and solid, 35–70 × 2–3 mm, widening to 5–6 mm in last 5 mm, mostly subterranean; *sepals* to 2 mm long, lanceolate; *corolla lobes* 10–12 × 3–4 mm, broadest just above middle, slightly narrower at base, with rounded obtuse apex, ascending-spreading, pale greenish and smooth outside, bright yellow and papillate within; *staminodes* 0–2 per lobe (5 per flower), pilose, erect, ± 2 mm long, inserted near base of petals; *ovary* ± ovoid, horizontal, 5–7 × 4–5 mm, pale

yellow, finely papillate; *style* 5–7 × 1.5–2.0 mm with broad cauliflower-like obscurely trifid apex, fused to receptacle about 4 mm below sepals. *Fruit* (only 1 seen) ± spherical, 22 mm diam., finely pubescent, green where exposed, white beneath soil. *Seeds* 8, white, flattened ovoid, 10 × 7 mm (not yet ripe). Flowering April to June. Figure 5.

Specimens examined

CAPE.—2917 (Springbok): Wildeperdehoek Pass, (–DC), *Bruijns* 5171 (BOL); 5 km S Pass, (–DC), *Bruijns* 5174 (BOL). 3017 (Hondeklipbaai): Riethuis, (–AB), *Bruijns* 4593 (BOL); 7 km S Taaibosduin, (–AD), *Bruijns* 4592 (BOL); NE Soebatsfontein, (–BA), *Bruijns* 5184 (BOL); Swartvlei, (–BD), *Bruijns* 5354 (BOL); Sandkraal, (–DA), *H. Taylor* 1378 (BOL); Nariep, (–DC), no material deposited. 3018 (Kamiesberg): Stofkraal, (–CB), *Bruijns* 4712 (BOL); Kliprand, (–DA), *Bruijns* 5268 (BOL). 3118 (Vanhynsdorp): Swartbooisvlei, (–AC), *Bayer* 6229 (BOL); Draaihoek, (–CB), *H. Taylor* 1146 (BOL). 3218 (Clanwilliam): Nortier, (–AB), *Bayer* (BOL); *Bruijns* 4569 (BOL, PRE, K, M); Grootdriif, (–AD), *Bruijns* 4738 (BOL); Redelinghuys, (–BC), *Bruijns* 4737 (BOL).

The Cucurbitaceae are a relatively small family in southern Africa with eight genera and 72 species (Meeuse 1962; Gibbs Russell *et al.* 1987; De Wet *et al.* 1991). The family is mainly found in those parts of the subcontinent receiving summer rainfall with only about five species (of the genera *Melothria*, *Kedrostis* and *Cucumis*) native to the western Cape. Most of them are creepers or climbers, often with a large tuberous rootstock and characteristic cucumber- or pumpkin-like fruit.

According to the key in Meeuse (1962), the present new species belongs to *Kedrostis* Medik. and is the ninth species known in southern Africa.

K. psammophila has less of a climbing or scandent habit than any other southern African species. The aerial stems are short and usually prostrate. They lack tendrils, which are found on all other southern African species of *Kedrostis*. Beneath the surface the stems spread extensively and are repeatedly branched so that the largest, central tuber can be very difficult to locate. Subsidiary tubers are sometimes found at the nodes at intervals along these underground stems and it is from these underground stems too that the inflorescences arise.

According to Meeuse (1962: 24), in *Kedrostis*, the male and female flowers are often borne on separate inflorescences with the males usually clustered and the females either clustered or solitary. This always appears to be the

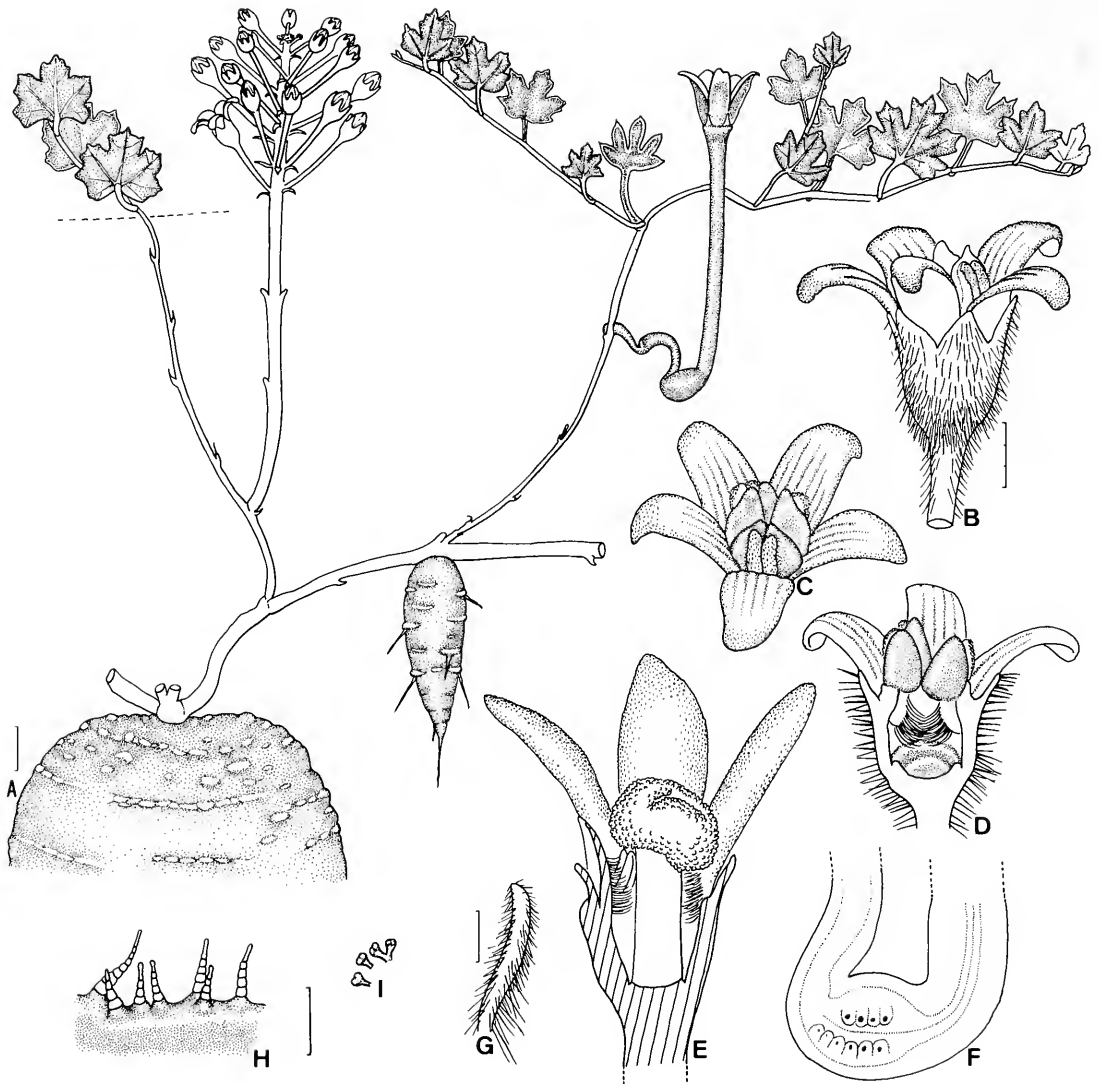


FIGURE 5.—*Kedrostis psammophila*. A, part of plant showing male inflorescence with many small flowers and female inflorescence with single flower longer and larger than male; dotted line on left indicates ground level. B, C, male flower; D, dissection of male flower; E, dissection of top of female flower; F, dissection of inflated base of female flower showing ovules; G, staminode from female flower showing hairs; H, hairs on edge of leaf; I, papillae on corolla surface. Scale bars: A, 10 mm; B–F, 3 mm (at B); G, 1 mm; H, I, 0.5 mm.

case in *K. psammophila*. He found that in general the female and male calyces and corollas are identical, but this is not true of the new species. Here the males are borne on a \pm dense pedunculate inflorescence protruding from the soil and they are small and green. The bright yellow female corolla is about twice the size of the male. It has an extremely long solid receptacle with the ovary at its base close to the stem and well below the ground and the corolla situated just above the surface of the soil. This leads to the remarkable situation of the fruit developing beneath the soil and makes *K. psammophila*, along with *Cucumis humifructus* Stent, only the second known geocarpic cucurbit in southern Africa (Meeuse 1962: 62). Female flowers were found to be much rarer than male but a few were observed on the same plants as males.

The plants are therefore generally assumed to be monoecious.

I have been unable to locate any herbarium records made prior to 1986 in any of the western Cape herbaria and it is remarkable that this widespread and common species has not been noticed earlier. The species was brought to my attention by M.B. Bayer, who noticed the unique flowering habit in plants growing wild near the Agricultural Research Station at Nortier. It has since turned out to be widespread in the fine reddish sand found over most of western Namaqualand from Redelinghuys in the south to around Port Nolloth (Figure 6). It occurs on this sand eastwards to the foothills of the Khamesberge and is also found in patches of relatively soft

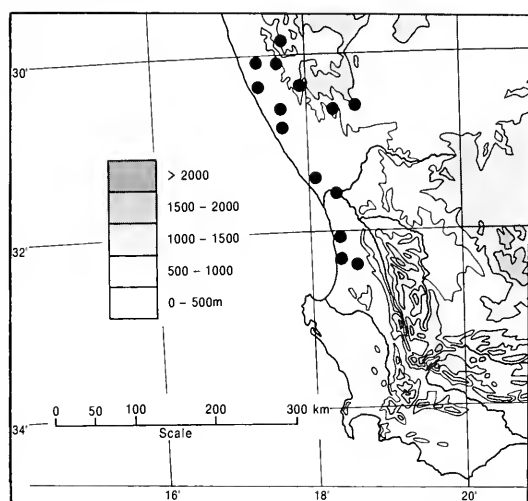


FIGURE 6.—Distribution of *Kedrostis psammophila*.

gneissic sand (much more gravelly than the coastal sands) higher up on the southern side of the Khamiesberge as far east as Kliprand.

Finding fruit of this species proved difficult and I have only seen one (Bruyns 5174). This had been partially ex-

posed by erosion of the soil above it and was probably not quite fully developed. It contained eight relatively large seeds (some dissected ovaries contained up to 10 ovules) and was extremely smelly when opened. In fact, when damaged all parts of the plant give off the unpleasant foetid odour characteristic of *Kedrostis*. Meeuse mentions that *C. humifrutus* is dispersed by antbears. I have, though, noticed no particular concentrations of *K. psammophila* around the ground squirrel warrens which are common in the sandier parts of Namaqualand and its seeds may be dispersed by moles.

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SAPOTACEAE

A 'BEQUAERTIODENDRON' BY ANY OTHER NAME?

The taxonomy and nomenclature of the genus *Bequaertiodendron* De Wild. have caused considerable controversy over the last thirty years. To complicate matters, two recent revisions, one of *Bequaertiodendron* (Liben 1989) and the other of the genera of the Sapotaceae (Pennington 1991), differ markedly from each other.

Chrysophyllum magalismontanum was described by Sonder (1850) and based on Zeyher 1849, a specimen from the Magaliesberg. This species as well as *C. natalense* Sond. and *C. glomeruliferum* Hutch. & Dalz. have fruit characters which separate them from the rest of the genus. The need to recognise this group as a separate entity prompted various researchers to describe new genera and sections in which members of the group could be accommodated. Thus, *Chrysophyllum* L. sect. *Zeyherella* Pierre ex Engl., *Pachystela* Pierre ex Engl. sect. *Zeyherella* (Engl.) Lecomte, *Tisserantiodoxa* Aubrév. & Pellegr., *Zeyherella* (Engl.) Aubrév. & Pellegr., *Boivinella* Aubrév. & Pellegr. and *Neoboivinella* Aubrév. & Pellegr. originated.

The genus *Bequaertiodendron* was established by De Wildeman (1919) and was based on *Bequaert* 2483 from the Belgian Congo. *Chrysophyllum magalismontanum* Sond. was considered to be congeneric with the type species of the genus, namely *Bequaertiodendron congolense* De Wild. This meant that the concept of *Bequaertiodendron* had to be broadened, and this was done by Heine & Hemsley in 1960, hence *Bequaertiodendron* De Wild. emend. Heine & J.H. Hemsley.

The genus *Englerophytum* was described by Krause in 1914 and typified by *Englerophytum stelechantha* Krause. It comprises five to ten poorly defined species in tropical Africa. *Bequaertiodendron* was reduced to synonymy under *Englerophytum* by Aubréville in 1960. However, Heine & Hemsley (1960, 1968) did not recognise this genus for the following reasons: the type material was thought to have been destroyed, the diagnosis and illustrations did not fully agree, and the genus was described without fruits.

Liben (1989), in a revision of the West and Central African species, concluded that the material placed in *Bequaertiodendron magalismontanum* by Heine & Hemsley (1960) could be divided into eight different species. On the basis of macromorphological floral and seed characters, these species were grouped into three genera, namely *Englerophytum* Krause, *Wildemaniodoxa* Aubrév. & Pellegr., and *Zeyherella* (Pierre ex Engl.) Aubrév. & Pellegr. Liben (1989) reduced *Bequaertiodendron magalismontanum* to synonymy under *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr.

Steyn (1990), in an attempt to retain *Bequaertiodendron magalismontanum*, used macromorphological characters of female and hermaphroditic flowers from gynodioecious populations to evaluate Liben's concept of *B. magalismontanum sensu lato*. According to Steyn (1990), characters which distinguish the southern African *B. magalismontanum* from the tropical African material are the presence of a stylar compitum, an ovarian nectary,

introrse apiculate stamens, or staminodes derived from such stamens, and a tendency in female plants to increase to ten the number of corolla lobes, of epipetalous staminodes and of locules. It is also emphasised that the staminal structure of southern African plants and *Englerophytum* (*sensu* Liben 1989) differ considerably. In the latter genus short filaments are united in a staminal tube that adheres tightly to and completely covers the pistil and bears nonapiculate anthers.

Pennington (1991) reduced *Bequaertiodendron* to synonymy under *Englerophytum*, because of the rediscovery of authentic material of the type species of *E. stelechanthum* (Aubréville 1971). He pointed out that closely related species groups in Sapotaceae are often highly variable in the number of their floral parts. An examination of the *Englerophytum* complex throughout its range showed that there was no clear distinction between free stamens and those fused into a tube, but rather a range of conditions from free, through slightly fused to completely fused. As a whole, the complex is characterised by a tendency towards fusion.

Concerning the genus *Bequaertiodendron* in southern Africa, it is clear that *Englerophytum* is the earlier name and Pennington's treatment of the genus should be followed. Nevertheless, on the basis of characters pointed out by Steyn (1990), it is recommended that more research should be undertaken at species level within *Englerophytum*. The NBI agrees with Pennington's views and accepts the following name changes:

***Englerophytum magalismontanum* (Sond.) Pennington**, The genera of Sapotaceae: 252 (1991).

Clrysophyllum magalismontanum Sond.: 72 (1850). *Pachystela magalismontana* (Sond.) Lecomte: 189 (1919). *Zeyherella magalismontana* (Sond.) Aubrév. & Pellegr.: 37 (1958). *Pouteria magalismontana* (Sond.) Meeuse: 335 (1960). *Bequaertiodendron magalismontanum* (Sond.) Heine & Hemsley: 307 (1960).

***Englerophytum natalense* (Sond.) Pennington**, The genera of Sapotaceae: 252 (1991).

Clrysophyllum natalense Sond.: 72 (1850). *Boivinella natalensis* (Sond.) Pierre ex Aubrév. & Pellegr.: 37 (1958). *Neoboivinella natalensis* (Sond.) Aubrév. & Pellegr.: 23 (1959). *Pouteria natalensis* (Sond.)

Meeuse: 339 (1960). *Bequaertiodendron natalense* (Sond.) Heine & Hemsley: 308 (1960).

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ASCLEPIADACEAE

VALIDATION OF THE COMBINATION *ASPIDONEPSIS REENENSIS* (ASCLEPIADACEAE): THE TYPE SPECIES OF THE SUBGENUS *UNGULOBIUM*

In our paper describing the new African genus *Aspidonepsis* (Nicholas & Goyder 1992), the basionym of *A. reenensis* was inadvertently omitted, so invalidating the proposed combination. As this invalid combination is the type of the proposed subgenus *Unguilibium* this too becomes invalid. The present note is intended to correct these omissions.

***Unguilibium* A. Nicholas & D.J. Goyder ex A. Nicholas & D.J. Goyder** in *Bothalia* 22: 31, 32 (1992), subgen. nov.

Folia ascendunt, margine manifeste revoluta. *Inflorescentia* 4–11-flora. *Corolla* reflexa; pagina abaxialis pubescentia. *Coronae lobi* ad columnam staminalem circa 1 mm super insertionem corollae conjuncti, cucullati; appendix proximalis ad apicem deltato-falcata et apicem styli aequans vel superans impendensque; extremum distale coronae appendice parva ornatum (*A. reenensis*) vel appendix carente (*A. shebae*); sinus profundus rimiformis.

TYPUS.—*Aspidonepsis reenensis* (N.E. Br.) A. Nicholas & D.J. Goyder *vide infra*.

Aspidonepsis reenensis (N.E. Br.) A. Nicholas & D.J. Goyder, comb. nov. Type: South Africa, Natal, Van Reenen, Wood 8635 (K!, holo.; GRA!, NH!, PRE!, SAM!, iso.)

Asclepias reenensis N.E. Br. in W.T. Thiselton-Dyer, *Flora capensis* 4,1: 1131 (1909).

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NICHOLAS, A. & GOYDER, D.J. 1992. *Aspidonepsis* (Asclepiadaceae), a new southern African genus. *Bothalia* 22: 23–35.

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The vegetation of the southern Langeberg, Cape Province. 3. The plant communities of the Bergfontein, Rooiwaterspruit and Phesantefontein areas

D.J. MCDONALD*

Keywords: classification, forest, fynbos, Langeberg, phytosociology

ABSTRACT

The fynbos shrubland communities of the southeastern Langeberg, Cape Province were analysed after sampling 97 quadrats in the Bergfontein, Rooiwaterspruit (Garcia's Forest Reserve) and Phesantefontein areas. Data were initially analysed using TWINSPLAN and the resulting classification refined using Braun-Blanquet (BB) procedures. One Afromontane forest community and 16 fynbos communities are recognized and described. A hierarchical classification of the fynbos communities is proposed.

UITTREKSEL

Die fynbos-struikgemeenskappe van die suidoostelike Langeberge, Kaapprovinsie, is geanaliseer. 'n Totaal van 97 monsterpersele in die Bergfontein-, Rooiwaterspruit- (Garcia Staatsbos) en Phesantefontein-gebiede is ondersoek. Data is aanvanklik deur Twinspan geanaliseer en die resultaat d.m.v. Braun-Blanquet prosedures (BB) verfyn. Een Afro-montane woudgemeenskap en 16 fynbosgemeenskappe word erken en beskryf. 'n Hiërargiese klassifikasie van die fynbosgemeenskappe word voorgestel.

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INTRODUCTION

A survey of the vegetation of the southern Langeberg was undertaken to describe the plant communities of this previously poorly documented mountain range. The descriptions of plant communities presented here are based on samples taken on the third of three sample transects

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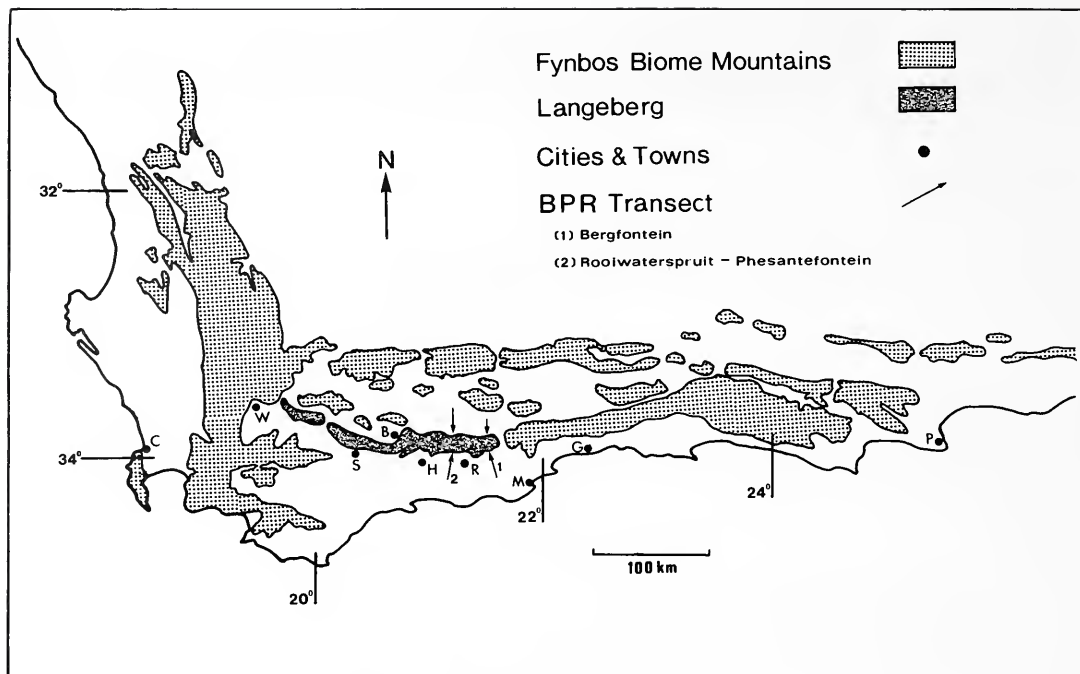


FIGURE 1.—Map of the mountains of the Fynbos Biome showing the position of the Langeberg and the location of the Bergfontein-Rooiwaterspruit-Phesantefontein areas. B, Barrydale; C, Cape Town; G, George; H, Heidelberg; M, Mossel Bay; P, Port Elizabeth; R, Riversdale; S, Swellendam and W, Worcester.

straddling the Langeberg at intervals between Swellendam and the Gouritz River. Each transect is treated separately (McDonald 1993a & b) but whereas the Marloth Nature Reserve (MNR) and Boosmansbos Wilderness Area (BWA) transects were more or less continuous from south to north, the third transect is a composite of samples from the Bergfontein area and the Rooiwaterspruit-Phesantefontein area (BRP) (Figure 1). This presented certain problems with respect to data analysis and interpretation which are discussed below.

STUDY AREA

Location

Numerous extensive wildfires have occurred on the Langeberg between Garcia's Pass and the Gouritz River in the past ten years (C. Martens pers. comm.). The fynbos vegetation on this part of the Langeberg is therefore almost all in a juvenile phase (<10 years) (Kruger 1979). Little choice was left in finding mature fynbos along a continuous transect for sampling vegetation on the third transect over the southern Langeberg. A transect which satisfied most logistic and sampling criteria was selected in the Bergfontein area, 33° 58' S, 21° 33' E. This area lies northeast of Riversdale, approximately midway between Garcia's Pass and the Gouritz River and is in the most easterly zone of the Langeberg. One negative feature was that the vegetation at Bergfontein was seven years old. However, despite the structural immaturity of the fynbos communities, the vegetation was in the 'maturing' successional phase (Kruger 1979) with the non-ephemeral species well established. It was therefore accepted that the floristic composition would reflect the 'mature' phase adequately and sampling could proceed.

The boundaries of the study area at Bergfontein followed the boundary between State Forest land and private agricultural land. The northern extreme of the designated transect extended onto private land where the vegetation was not disturbed by agriculture.

The Bergfontein transect followed the bridle path (Muir 1929) and sampling was largely confined to south- and southwest-facing slopes east of Witelsrivier. Four sample plots were located west of Witelsrivier opposite the western end of Kokspasberg to accommodate the *Erica hispidula*-*Protea nitida* Shrublands not found in the remainder of the study area.

Shortly after 74 relevés had been recorded on the southern slopes of the Bergfontein transect, a wildfire destroyed all the vegetation on the transect. Therefore alternative sites with vegetation and habitat as similar as possible to the vegetation on the northern slopes and high-altitude south-facing slopes had to be found. Since no suitable sites were available east of Garcia's Pass, alternative sites were chosen west of Garcia's Pass above Rooiwaterspruit (high-altitude south-facing slopes) and above Phesantefontein (north-facing slopes) 33° 57' S, 21° 9' E.

At Rooiwaterspruit, which falls within the Garcia's Forest Reserve, four relevés (301–304) were recorded in vegetation on the Cedarberg Formation shaleband east of Stinkhoutbos. One plot (297) was located on the western side of the watershed between the headwaters of Rooiwaterspruit and Korinte River and three plots (298–300) were located on the steep, high-altitude south-facing slopes of the unnamed peak immediately west of Sleeping

Beauty (near trigonometric beacon 48). This latter peak is referred to as Korinteberg.

Above Phesantefontein, eight plots (286–293) were located in seven-year-old veld on the mid-altitude north-facing slopes east of Aasvoëlkrans (Garcia's Forest Reserve) and a further six (282–285, 295 & 296) in mature veld (>20 years) on the lower northern foothills of the Langeberg (Phesantefontein Farm).

Physiography and geology

Bergfontein

The south slopes of the Langeberg above Bergfontein are not as steep as the south slopes of the range further west. At the forefront of the mountain is Koksposberg, a prominent, isolated, low ridge-like hill or 'koppie'. This hill and others similar to it, to the west and east, ranging in altitude from 457–727 m and situated between the Kaffirkuils and Gouritz Rivers, are the remnants of the Peninsula Formation sandstone which is much more prominent further west. South of Koksposberg is a silcrete-capped mesa which supports fynbos. This area was excluded from the study since it fell outside the southern boundary of the transect and has been disturbed by agricultural practices. Immediately north of Koksposberg is the Cedarberg Formation shaleband which separates the Peninsula Formation sandstone from the Nardouw Subgroup sandstone. There is no deeply incised intermontane valley following the shaleband as there is in other parts of the Langeberg e.g. in BWA (McDonald 1993a). North of the shaleband is another 'koppie', of higher altitude than Koksposberg consisting of Nardouw Subgroup sandstone. Further north is Witelsberg which is a massive block of Nardouw Subgroup sandstone with steep south and north sides but with an expansive 'flat' top with shallow gradient from the west to the peak at 1 166 m at the eastern end.

Below the steep north slopes of Witelsberg is a plateau extending from west of Witelsberg to Waboomsrivier. North of the plateau is a dissected sandstone ridge which gives way to arid sandstone slopes. They in turn make contact with the Bokkeveld Group shales of the Little Karoo.

Rooiwaterspruit and Phesantefontein

In the Garcia's Forest Reserve west of Garcia's Pass, the Peninsula Formation sandstone forms massive peaks on the southern side of the mountain range. Sleeping Beauty (1 343 m) is the most prominent peak with Korinteberg (1 330 m) to the west and lower peaks further westwards towards Gysmanshoek. Behind the peaks lie two incised valleys where streams have eroded the shales of the Cedarberg Formation. North of the shaleband lies the Nardouw Subgroup sandstone with Aasvoëlkrans west of Stinkhoutbos reaching 1 341 m and another prominent peak east of Stinkhoutbos with a height of 1 330 m, referred to here as Phesanteberg.

Below the southern slopes of the mountain the Peninsula Formation sandstones make contact with silcrete-capped plateau-like mesas which in turn are dissected by

numerous watercourses. The high northern slopes of Nardouw Subgroup sandstone grade at a moderate angle to the undulating foothills at Phesantefontein. The foothills consist of sandstone overburden and the remains of a once extensive silcrete-capped landscape. Remnant mesas are encountered extending well into the Little Karoo (Figure 2).

Soils

The soils of the Bergfontein and Rooiwaterspruit-Phesantefontein areas of the Langeberg are the same as those of the MNR and BWA (McDonald 1993a & b) at the level of 'form' (SCWG 1991). The climate of the three areas is similar (see below) as is the geology. Topographical variation and changes in parent material therefore account for most differences between the soils encountered on the BRP 'transect' and those of BWA and MNR. A description of the soil forms found on the southern Langeberg is given in McDonald (1993a); a summary of soil forms found on the BRP 'transect' follows:

Champagne Form soils are found at sites where there is a deep (>200 mm) accumulation of organic material. On the BRP transect such sites are found mainly at high altitude on cool, moist south-facing slopes e.g. on Korinteberg. These soils also occur at lower elevations often in depressions where plant remains collect.

The catena of 'non-organic' soils derived from sandstone parent material in the study area include Houwhoek, Cartref, Glenrosa and Mispah Forms. Houwhoek and Cartref Form soils are closely related. The characteristics they share are an orthic A-horizon and presence of an E-horizon. They differ in that Houwhoek Form has a podzolised B-horizon overlying saprolite, whereas Cartref Form has a lithocutanic B-horizon. Glenrosa Form is similar to Cartref but lacks the eluviated E-horizon of the former. Mispah Form in turn is similar to Glenrosa Form, but here the orthic A-horizon overlies hard rock as opposed to the lithocutanic B-horizon of Glenrosa Form.



FIGURE 2.—Silcrete mesas on the north flank of the Langeberg, extending into the Little Karoo, at Phesantefontein.

Clovelly Form soils which have an orthic A-horizon over a yellow-brown apedal B-horizon are found in two situations derived from different parent materials: 1, on the Cedarberg Formation shale both at Bergfontein and at Rooiwaterspruit, behind Korinteburg; and 2, where there is accumulation of sand derived from Nardouw Subgroup sandstones, on dry north-facing slopes where leaching is limited.

Oakleaf Form soils which have limited extent in BWA (McDonald 1993a) but which were not identified in MNR occur on the lower south slopes at Bergfontein, below Koksposberg and on the west side of Witelsrivier. These soils which result from mixing of shale and sandstone have an orthic A-horizon and a reddish brown neocutanic B-horizon.

Climate

Characteristics of the climate of the BPR 'transect' are similar to those described by McDonald (1993a & b) for BWA and MNR. The southern Langeberg falls within a uniform bioclimatic zone, transitional between the winter rainfall region in the west and the year-round rainfall region in the east. The major climatic events which affect the weather of the southern Cape coast and the coastal mountains are the passage of cold fronts advancing from west to east, coastal lows and cutoff lows (Fuggle 1981; Van Heerden & Hurry 1987). A Walter-Lieth climate diagram for Riversdale (Figure 3A) gives an approximation of the climate of the lower south slopes of the Langeberg in the Riversdale-Gouritz River District.

Winds

The direction of surface winds affecting the southern Langeberg is dependent on season with summer winds blowing mainly onshore and winter winds mainly offshore. Calm periods occur approximately one-third of the time in both summer and winter (Schulze 1965).

Extreme fire-hazard conditions prevail when hot, dry berg winds occur in the southern Cape, mainly in winter (Van Wilgen 1984). They arise from air subsiding in response to pressure gradients between an established anticyclone and an advancing depression (Fuggle 1981). The fire which swept through the Bergfontein area in May 1991 occurred in such conditions.

Precipitation

Precipitation on the Langeberg is from rain, mist and snow. Snowfalls occur once or twice each winter mainly on the high peaks and ridges and do not persist. Mist is a year-round phenomenon, usually occurring at elevations from 1 000 m upwards. Rainfall occurs throughout the year with peaks in autumn (April) and spring (October). It may occur from unstable prefrontal conditions but is most often associated with postfrontal events. Eastward-moving cold fronts are usually followed by a 'ridging-in' by the South Atlantic anticyclone behind the fronts. Air movement over the warm Agulhas Current results in on-shore advection of cool moist air (Cowling 1984; Preston-Whyte & Tyson 1988). Orographic rain occurs when this moist air strikes the coastal mountains.

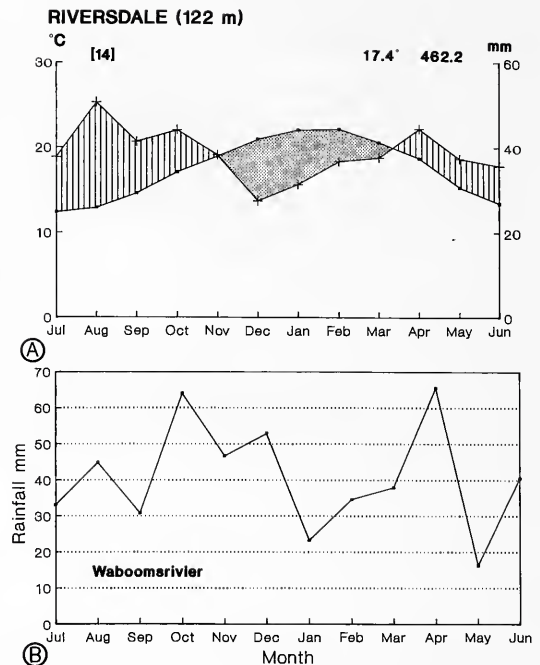


FIGURE 3.—A, climate diagram for Riversdale which approximates the climate of the lower south slopes of the Langeberg in the Riversdale-Gouritz River District; B, monthly rainfall (1984–1991) at Waboomsriver on the north side of Witelsberg, showing peaks in April (autumn) and October (spring).

The high peaks in the MNR at Swellendam and in BWA receive an estimated 1 200–1 400 mm rainfall per annum. Proceeding eastwards, Kanetberg receives 500–600 mm, Aasvoëlkrans 600–700 mm, Korinteburg 700–800 mm and Sleeping Beauty 800–900 mm rainfall p.a. East of Garcia's Pass the peaks receive from 800–900 mm rainfall but the Bergfontein area (including Witelsberg south slopes) is much drier, receiving 600–700 mm rainfall p.a. (Dent *et al.* 1987). This gradient is opposite to that reflected in the mean annual rainfall for Heidelberg (378 mm) and Riversdale (426 mm) (Rebello *et al.* 1991). The difference is attributed to the effect of orographic rainfall on the Langeberg; the more westerly higher altitude peaks receive more rainfall than the somewhat lower eastern part of the Langeberg close to the Gouritz River.

The north slopes of Witelsberg are in a rain shadow and are consequently much drier than the southern slopes. The mean annual precipitation for a seven-year period (1984–1990) at Waboomsriver at the northern base of Witelsberg was 496 mm (P.E. Wadman pers. comm.); seasonal distribution of the rainfall is as shown in Figure 3B. Rooiwaterspruit and Korinteburg receive a mean annual precipitation of 700–800 mm, whereas the upper north slopes above Phesantefontein (east of Aasvoëlkrans) receive 500–600 mm and the lower north slopes 300–500 mm depending on locality (Dent *et al.* 1987).

Temperature

No temperature data are available for the study area; a situation commonplace in the Cape mountains where there are few weather stations (Bond 1981; Fuggle & Ash-

ton 1979; Fuggle 1981). Extrapolation of temperature data from 'lowland' weather stations to montane situations has been done (Van Wilgen 1984) but this does not reflect the true montane temperature regime in most cases. The closest temperature recording station to the study area is at Riversdale. Temperatures recorded here may approximate those experienced on the lower south slopes of the Langeberg. Therefore, if the environmental lapse rate of $0.6^{\circ}\text{C}/100\text{ m}$ (Cowling 1984) is used to predict montane temperatures, the high altitude south-facing slopes of Witelsberg at 1 150 m are predicted to have temperatures 6.26°C lower than Riversdale at 106 m.

Solar radiation

Incoming radiation may be measured directly (Morris 1981), which is cumbersome in mountainous terrain, or derived from sunshine duration. No data are published for sunshine duration on the Langeberg. Bond (1981) used Swift's (1976) algorithm to calculate potential radiation for a range of slopes and aspects for the $33^{\circ} 30' \text{ S}$ latitude which is roughly equivalent to the latitude for the southern Langeberg. Bond (1981) found that potential radiation on the Swartberg and Outeniqua Mountains is relatively similar on all aspects and slopes in summer, with marked differences between north and south aspects, particularly on steep slopes, in winter. This holds for the Langeberg as well.

METHODS

Ninety-seven $5 \times 10\text{ m}$ quadrats (McDonald 1983, 1988, 1993a & b; Campbell 1985; Boucher 1987) were sampled on a 'composite transect' over the Langeberg in the Bergfontein, Rooiwaterspruit and Phesantfontein areas. No stratification of the study area was undertaken since no suitable aerial photography was available. Plots were therefore subjectively placed at sites representative of major landscape features and vegetation communities.

Floristic, structural and environmental data were collected from each sample plot. Permanently recognizable species were recorded using the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974; Werger 1974; Westhoff & Van der Maarel 1973). The midpoint of the BB values given as percentage cover is as follows: 5 = 87.5%; 4 = 62.5%; 3 = 37.5%; 2 = 15.0%; 1 = 2.5%; + = 0.1% ; R = value ignored. Ephemeral geophytes and annuals were noted in each relevé but were not used in analyses and descriptions of communities. A border zone of 1.5 m from the perimeter of each plot was searched for any species not found in the marked plot. Species occurring outside the plot are represented by 'O' in the phytosociological tables. Vegetation structure was measured by estimating the projected canopy cover and height of the respective strata. Environmental variables recorded include altitude, aspect, slope, geology, soil form, drainage and estimated soil depth. Mean annual rainfall was estimated from isohyet maps prepared by Dent *et al.* (1987).

Samples were taken only in fynbos shrubland communities. Stinkhoutbos in the Rooiwaterspruit area is a well-developed stand of Afromontane Forest but was not formally sampled (see below).

Two-way Indicator Species Analysis—TWINSPAN (Hill 1979a) was used to obtain an initial tabular classification of the data. This was followed by successive refinement of the phytosociological tables following the Braun-Blanquet method (Mueller-Dombois & Ellenberg 1974; Werger 1974) using the PCTables programs (Boucher pers. comm.). Detrended Correspondence Analysis—DECORANA Hill 1979b) was used to assess the relationship of the *Erica versicolor*–*Agathosma ovata* Shrublands to the other shrublands in the Bergfontein area (see below).

The plant communities are described in the order of the proposed hierarchical classification (see above). No syntaxonomic rank is assigned to any given community. Structural description follows the *a priori* system of Campbell *et al.* (1981).

The 'relationships' between communities described in this study and those described in other, previous studies of Mountain Fynbos were determined on the basis of floristic (mainly) and structural similarity. The similarities were determined from published descriptions and phytosociological tables. No rigid system was applied and the relationships serve merely as a guide for future synthesis of fynbos communities.

VEGETATION

The primary objective of a study such as this is to characterize the plant communities of a given area so that they may be repeatedly identified where they occur in the landscape. The early descriptions of the vegetation of the southeastern Langeberg by Muir (1929) in his treatment of the vegetation of the Riversdale area are highly informative but, apart from a broad classification, do not provide clear delineations of the fynbos communities. The fynbos vegetation sampled on the composite BPR 'transect' is classified into 16 communities: 10 at Bergfontein, two at Rooiwaterspruit and the remaining four at Phesantfontein. One Afromontane Forest community is recognized. The classification of the plant communities of the BPR transect is not complete since the scale of the study dictated that not all communities could be exhaustively sampled in the limited study area. Emphasis is on the sclerophyllous fynbos plant communities, since communities of this type make up the major part of the vegetation in the study area. Afromontane Forest communities are extremely limited in extent.

The vegetation of the south slopes of the Bergfontein area is mainly wet to mesic proteoid fynbos with a few isolated patches of trees in protected places. These trees such as *Cimonia capensis* are representative elements of Afromontane Forest. A well-developed stand of this forest type is located on an east-facing cliff of Perdeberg opposite Witelsberg. This forest is difficult to reach and fell outside the study area so it was not sampled. On the northern extreme of the Bergfontein transect, i.e. on the lower north slopes of Witelsberg, dry proteoid fynbos is encountered.

At Rooiwaterspruit, the south slopes also support wet proteoid and ericaceous fynbos with one well-developed patch of Afromontane Forest, Stinkhoutbos, in a moist

kloof or ravine. The north-facing slopes above Phesantfontein have mesic proteoid to dry asteraceous fynbos communities.

During preparation of the phytosociological tables it was initially doubted whether relevés taken in mature or senescent vegetation (sensu Kruger 1979) would be satisfactorily accommodated, for reasons such as lack of differential species and overriding dominance of tall shrubs. It was interesting to note, however, that these relevés were appropriately placed in the tables and that they gave insights into the nature of the respective communities when they reach the mature and senescent phases (see 1.3.1 and 1.3.2.1 below).

Afromontane Forest

The description of Afromontane Forest is confined to the community found at Stinkhoutbos (Figure 4). No samples were taken in this forest which covers approximately 2 ha. A list of species confirms that it may be classified as the *Cunonia capensis*–*Platylophus trifolius* Sub-association (McKenzie 1978), also found in BWA (McDonald 1993a). As the colloquial name of the forest stand suggests, the stinkwood *Ocotea bullata* is common and co-dominant with *Cunonia capensis* and *Platylophus trifolius* in the canopy. *Virgilia oroboides* forms large trees mainly on the forest margins. *Plectranthus fruticosus* is the dominant understorey shrub.

Fynbos

1. *Erica hispidula* Shrublands

The role of *Erica hispidula* in linking the fynbos communities of the mesic to wet slopes of the southwestern and southern Cape mountains has been indicated by McDonald (1993a & b). The south slopes of the Langeberg at Bergfontein and Rooiwaterspruit are no exception. *Erica hispidula* is found in all the fynbos communities at Bergfontein except in the *Tetraria bromoides*–*Phylla*

pinea Shrublands and with little occurrence in the wet *Erica hispidula*–*Brunia alopecuroides* Shrubland sampled on Korinteborg. The *Erica hispidula*–*Restio inconspicuus* Shrublands include the very wet high altitude shrublands on the south-facing slopes of the peaks, as well as shrublands forming part of the mosaic of communities on the mid and lower south-facing slopes of the Bergfontein area.

1.1 *Erica hispidula*–*Brunia alopecuroides* Shrublands

Differential species: *Brunia alopecuroides*, *Erica albens*, *E. mucronata*, *E. regerninans*, *E. transparens*, *Hippia integrifolia*, *Helichrysum capense*, *Indigofera concava*, *Lobelia pubescens* var. *rotundifolia*, *Restio fragilis*.

Dominant species: *Anthochortus crinalis*, *Brunia alopecuroides*, *Spatalla parilis*, *Platycaulos compressus*.

Structural formation: Low Closed Restioid Shrubland.

Relationships: *Brunia alopecuroides*–*Restio bifidus* Community (Kruger 1974); Subcommunity E2 of the *Erica*–*Penaea* Community (Glyphis *et al.* 1978); *Restio*–*Hypolaena* Subcommunity (H & I) (Laidler *et al.* (1978); Ericoid–Restioid Zone Fynbos (Taylor 1978); Low Narrow–sclerophyllous Heathland (Kruger 1979); *Simocheilus carneus*–*Restio anceps* Community (Bond 1981); Wet Mountain Fynbos (Moll *et al.* 1984); Ruitersberg Wet Ericaceous Fynbos (Campbell 1985); *Erica hispidula*–*Spatalla nubicola* Shrublands and *Restio inconspicuus*–*Anthochortus crinalis* Shrublands (McDonald 1993a); *Anthochortus crinalis*–*Erica curviflora* Shrublands (McDonald 1993b).

Owing to the fire in the Bergfontein area during this survey, sampling of the vegetation of the high altitude south-facing slopes of Witelsberg was not possible. As a substitute, four samples (297–300) were taken on similar slopes on Korinteborg. The community represented is equivalent to that found on Witelsberg prior to the fire (D.J. McDonald pers. obs.).

Moist air moving onshore from the southern Cape coast, together with mist and stratus cloud result in high orographic precipitation on the high altitude (above 1 000 m) south-facing slopes. The high precipitation, low temperature and reduced insolation result in low rates of organic matter decay and consequent accumulation of deep layers of peat-like material. This deep acid peat (pH 3.0 in 1 mol/l CaCl_2) with underlying Peninsula Formation sandstone, or Champagne Form soil, supports the *Erica hispidula*–*Brunia alopecuroides* Shrublands which are typical of these habitats (McDonald 1993a & b).

The *Erica hispidula*–*Brunia alopecuroides* Shrublands on Korinteborg (Figure 5) are well differentiated floristically (Table 1) with dense stands of mid-high *Brunia alopecuroides* shrubs dominating the upper stratum. *Spatalla nubicola* (Proteaceae), a narrow endemic, which is found in the equivalent shrubland community in the BWA (McDonald 1993a) is replaced by the closely allied *S. parilis* on Korinteborg. *Anthochortus crinalis* (Restionaceae), a dense mat–restio, dominates the understorey.

A specimen of *Erica dodii* was found in plot 298 on Korinteborg, which is the first record of this species on



FIGURE 4.—Stinkhoutbos, a patch of Afromontane Forest in a secluded kloof at Rooiwaterspruit.

TABLE 1.—Phytosociological table of the *Erica hispidula* Shrublands on the south slopes of the Bergfontein area, southern Langeberg (continued)

Relevé number	2223*2222222*2222222222*2222222222*2222222222*3333*222222*2222222222*222222*2222 9990*5566777*3335555777*223334445577*1144444566*0000*233335*1112222466*111224*6666 7890*8909346*1271267012*890890563457*2313489534*1234*734560*78902346212*456157*5678									
Species common to communities 1.2.1, 1.2.2, 1.2.3 & 1.3.1										
Restio inconspicuus Esterhuysen		2121+2	.+21+222+11.21111101	311.	0 + 11	1	.	.	.	.
Mevillea sp. nov.		122211	.+111++ 21.	21+	211.12	0+0	.	.	.	.
Berzelia galeonii Pillans		22 5 R	.+ 2	.+R23	4341	.+2+R	.	.	.	.
Agaoanthus africanus (L.) Hoffmg.		+11	.+ +	.+++ 0++	.+0	+	.	.	.	.
Edmondia sesamoides (L.) Hilliard		ROO	.+R1+RRR	.RRR11R	+ RO	.	.	.	+	0
Ursinia trifida (Thunb.) N.E. Br.		+++ R	.+ R ORR+	R R R R R	.R	.	.	R	.	+
Wahlenbergia fruticosa V. Brehm.		+	. R+RRR.	R	RR	.	.	R	.	.
Mairia crenata (Thunb.) Nees		RR	.+R R	R+	R	.+	.	.	.	.
Cullumia sp. (unidentified 237/17)		1	.+1	.	+1 1	. 1	.	.	.	.
Senecio ourple lf. underside (lanceolate)			.+R RR	.	RR	.R	.	.	.	.
Bobartia macrospatha Bak. subsp. anceps Strid			.	.	++	.+0 +0	.	.	.	.
Erica seriphilifolia Salisb.			.	.	.	.2 ++	.	.	.	.
Lachnaea so. nov.			.	++	.	.+ 0 1 +	.	.	.	.
Senecio ilicifolius (L.) Thunb.			.	.	0+	.R +	.	.	.	.
Species common to communities 1.1, 1.2.1, 1.2.2, 1.2.3 & 1.3.1										
Leucadendron spissifolium (Salisb. ex Knight)		+	.+111 22	.+2+ 2	+012.	.+ ++	. 0 0 22	.	1.	.
Drosera aliciae Hamet		P	.R R R	.RR R+	R	.RR RRR 0 RRR.	R R	.	.	.
Ficinia capillifolia C.B. Cl.		3	.	+	.	.	.	.	.	+
Differential species of the Ischyrolepis hystrix--Phylica rubra Shrublands (1.3.2.1)										
Phylica rubra Willd.		.	.	.	.	.	+312	.	.	.
Cyclopia sessiliflora Eckl. & Zeyh.		+	.	.	.	.	1R1	.	.	.
Indigofera sarmentosa L.		.	.	.	.	1	RRR	.	.	1.
Differential species of the Ischyrolepis hystrix--Phylica pinea Shrublands (1.3.2.2)										
Carpacoe spermacoea (Reichenb. f.) Sond. subsp.		.	.	.	.	.	0 + +	.	.	.
Knowltonia capensis (L.) Hutch.		.	.	.	.	.	0 12	.	0.	.
Serruria fasciflora Salisb. ex Knight		.	.	.	.	.	++ 0	.	.	.
Erica coccinea L.		.	.	.	.	.	++	.	.	.
Pelargonium cordifolium (Cav.) Curtis		.	.	.	.	.	+ 1	.	.	.
Species common to communities 1.3.2.1 & 1.3.2.2										
Ischyrolepis hystrix (Mast.) Linder		.	.	.1	.	+	12 +.202121	.	.	.
Phylica pinea Thunb.		.	.	.	.0	+	+. 22+4	.	0	+
Cannomois virgata (Rottb.) Steud.		.	.	.	.	.	11 1. 5225	.	.	.
Erica grata Guth. & Bol.		.	.	.	.	.	111. ++21	.	.	.
Protea aurea (Burm. f.) Rourke subsp. aurea		.	.	.	.	.	43 2. 112	.	.	.
Species common to communities 1.2.1, 1.2.2, 1.2.3, 1.3.1, 1.3.2.1 & 1.3.2.2										
Erica penicilliformis Salisb.		.+111 R	.R2 2+	.+1.1	.+ 1R 0.1+	+	. 11 +	.	.	.
Calopsis membranacea (Pillans) Linder		++ + .	.+11++12.	.	0	.+ +	.R2 . 311	.	.	.
Widdringtonia nodiflora (L.) Powrie		0002 +.	OR 1 +.	.	0	. 0	.21 +. +01+	.	.	.
Laurophyllus capensis Thunb.		+	.+ ++ 1	.	.	1	. 1+10	.	.	.
Elegia equisetacea (Mast.) Mast.		+	.	.	.11 2	+	. 1231	.	.	.
Differential species of the Tetralaria bromoides--Hypodiscus striatus Shrublands (1.3.3)										
Anomalanthus scoparius Klotzsch		.	.	2 1	.	.	.+ 1 1111213	.	+	.
Hypodiscus striatus (Kunth) Mast.		.	.	.	.	1	.1 12+ 321112	.	.	.
Heteropogon contortus (L.) Roem. & Schult.		.	.	.	.	.	++1 11	.	.	.
Diosma tenella Williams		.	.	.	.	.	+++	.	1.	.
Peucedanum ferulaceum Thunb. var. ferulaceum		.	.	.	.	.	0	.	.	.
Polygala so. (unidentified 222/31)		.	.	.	.	.	RO+	.	.	.
Elegia galpinii N.E. Br.		.	.	1	.	+	.	423	.	.
Species common to communities 1.3.2.2 & 1.3.3										
Osteospermum triquetrum L.f.		.	.	.	.	.	+2 3. +0 1	.	.	.
Centella virgata (L.f.) Drude var. virgata		.	.	.	.	.	+. + R. +1+ + ++	.	.	.
Otholobium sp. (1) (unidentified)		.	.	.	.	+	11+ . 2	.	.	.

TABLE 1.—Phytosociological table of the *Erica hispidula* Shrublands on the south slopes of the Bergfontein area, southern Langeberg (continued)

Relevé number	2223*2222222*2222222222*2222222222*3333*222222*2222222222*222222*2222 9990*5566777*3335555777*223334445577*1144444566*0000*233335*11122222466*111224*6666 7890*8909346*1271267012*890890563457*2313489534*1234*734560*78902346212*456157*5678									
Species common to communities 1.2.1, 1.2.2, 1.2.3, 1.3.1, 1.3.2.1, 1.3.2.2 & 1.3.3										
Merxmüllera rufa (Nees) Conert	1112	. 1	+1	. 3	R +	+2	. R	2+2R	1 1.	. ++ . + + +++
Erica triceps Link		. 3	+2	+	. 333	R+	2.1	11	R R.	1 2. . 2++
Hypodiscus aristatus (Thunb.) Krauss		. +1	+1112+			+1.2	+			. +1 + 1
Indigofera langebergensis L. Bol.		. +		. 1+12+	R1.	+				. +R ++1
Acmadenia trigona Eckl. & Zeyh.		. +					+		. + +	. ++ + 0+++1
Argyrobolium filiforme Eckl. & Zeyh.	R .RR			R .ORR	R		R R	R	. R R	. 0
Erica melanthera L.		. 1	+	. 4+0+2	+	34. 0				. + 1 +
Tetraria fasciata (Rottb.) C.B. Cl.		. +	+	12			22	2		. 2 0
Syncarpha paniculata (L.) B. Nord.		. 1	+	+	. +1					. 2+ R +1
Pelargonium ternatum (L.f.) Jacq.		. 1					+			. +
Differential species of the Tetraria bromoides--Protea coronata Shrublands (1.3.4)										
Alepidea capensis R.A. Dyer		. .	. .	. .	. .	. .	. .	. .	0	RRR
Protea coronata Lam.		. .	. .	. .	. .	. .	. .	. .	. .	1 +1
Erica cf. zwartbergense		. .	. .	. .	. .	. .	. .	. .	. .	++0 2
Otholobium so. (2) (unidentified)		. .	. .	. .	. .	. .	. .	. .	. .	1 21
Species common to communities 1.3.3 & 1.3.4										
Tetraria pillansii Levyns		. .	. +	. .	. .	. .	. .	. .	+ 21	. + 11
Tetraria capillacea (Thunb.) C.B. Cl.		. .	. .	. .	. .	. .	. .	. .	1 3	R.+
Species common to communities 1.3.1, 1.3.2.1, 1.3.2.2, 1.3.3 & 1.3.4										
Tetraria bromoides (Lam.) Pfeiffer		. .	. .	. 1			+ 2+1111+2.	+122.1+111.11	12122+ 2.	+12212
Gnidia galpinii C.H. Wr.		. .	. .	. .			++1+ ++ +.	. +R++ . +1	+	. +21+
Struthiola garciana C.H. Wright		. .	. .	. .			+	R. . ++	+++ ++ +R.	R
Psoralea monophylla (L.) C.H. Stirtion		. .	. .	. .			+21 R + +.	+. R+ 11.	0	. 1 1
Thesium carinatum A. DC.		. .	. .	. .			+	. . .	. + ++	R . 0
Clusia ericoides Thunb. var. tenuis Sond.		. .	. .	. .			+	. . ++11	. 1	. 11+
Sebaea stricta (E. Mey.) Gilg.		. .	. .	. .			+	R . .	+	. R 1
Athrixia heteroophylla (Thunb.) Less subsp. heterop		. .	. .	. .			. RR	R		. R
Hypodiscus albo-aristatus (Nees) Mast.		. .	. .	. .			2	21 . ++2.	R	. 2 1+
Aspalathus hypnoides Dahlg.		. .	. .	. .			+	11+.	. +++	. 1 1
Phyllica purpurea Sond. var. floccosa Pillans		. .	. .	. .			R	. . .	. +	++.
Species common to communities all communities except 1.1.1, 1.1.2										
Tetraria crassa Levyns		. .	+	+	. 2	+1 3	. 1	10	22++.	1 2.2++ . + + . + 22
Gerbera serrata (Thunb.) Druce		. .	+	. R	R	. 0+	R +	. .	. R++++1RR	. R 0+
Berzelia intermedia Schlecht.		. .	R	2	. 0	0+	. +	52	. 1 1.	24. . 0 11+
Psoralea pinnata L.		. .	1	+	2	. +2	. R	+	. 1R. ++	. + . RR+R
Indigofera flabellata Harv.		. .	+	. 0			+	. .	. + +R+ + 1	. 0
Stoebe alopecuroides (Lam.) Less.		. .	. +R	+	. 0		R.	. +	. + R	. 2+ +
Indigofera alopecuroides DC. var. minor		. .	+	+++	. +		+	. .	. 1	. 2 . + +
Tetraria fimbriolata (Nees) C.B. Cl.		. .	. .	+	+	. 1	+12	. .	. .	. 1
Metalasia sp. (unidentified 219/26)		. .	1	0	. +	. R	. .	. .	. ++	RR . +
Species common to communities 1.2.1, 1.2.2, 1.2.3, 1.3.1, 1.3.2.1, 1.3.2.2, 1.3.3 & 1.3.4										
Thamnochortus cinereus Linder		+	+	. +1101++++.1	111+ + 1+.20	+	+++.	R +. +0	. 1+ ++ 1+	. +
Ehrharta dura Nees ex Trin.		11	++	++ 1.	1 R+0	+	. +++	1+ 2.	2 R.	21 . + 2+ R . +222
Leucadendron eucalyptifolium Buek. ex Meisn.		4	2	. +	202+ R .2++	2231	1.55232	+122.3433.411211.3	401+ +233.55+12	
Staberoha cernua (L.f.) Dur. & Schinz.		1	2	. +2	224122.2	123	+0022.	12 +1 +.	. 22	221 1 . 0+ 1
Tetraria flexuosa (Thunb.) C.B. Cl.		++1	. 21	+3	32.	22212+ 43.1	23125	2.	. 22	2 22 . 20 2
Helichrysum felinum (Thunb.) Less		+	+	0 .11	++R + +. +R0	+1+	. 1+	. .	. +++	. +0 . +1+ 1R
Cullumia aculeata (Houtt.) Roesl. var. aculeata		+	. .	10	. 3	12	. 10+	+1++.	. 1+ 1R.	10 ++ +++.
Ficinia trichodes (Schrud.) Benth. & Hook. f.		+11	. 23+1	+	++1.	1+ ++1	. 2	. + . 2	+	R
Pentstemonis colorata (Steud.) Stapf		2	2	. 0+	+++ 2	. 1121	2. +	. RR.	. 1	0 . 43 1
Erica cubica L.		121	+	. 0	. +34R+	23	4	. R4	. .	. + 1 0 0 . +
Thesium virgatum Lam.		R	. R	+	+	. R.	+	. .	. ++	1++1+ . + +
Elegia asperiflora (Nees) Kunth		2	. .	R	. 21	2014	1. 0	31	. .	. +
Tetraria ustulata (L.) C.B. Cl.		21	. 1	2	. .	. .	. 3.	. .	. 2	. 1
Ehrharta ramosa (Thunb.) Thunb.		+	. +	R	. R	. .	. R	. .	. .	. .

TABLE 1.—Phytosociological table of the *Erica hispidula* Shrublands on the south slopes of the Bergfontein area, southern Langeberg (continued)

Relevé number	2223*2222222*2222222222*2222222222*22222222*3333*22222*222222222*22222*2222 9990*5566777*3335555777*223334445577*1144445666*0000*233335*1112222466*111224*6666 7890*8909346*1271267012*890890563457*2313489534*1234*734560*78902346212*456157*5678
Species common to communities 1.2.1, 1.2.2, 1.2.3, 1.3.1, 1.3.2.1, 1.3.2.2, 1.3.3, 1.3.4 & 1.4	
Tetraria cuspidata (Rottb.) C.B. Cl. Restio triticeus Rottb. Ficinia filiformis (Lam.) Schrad. Pteridium aquilinum (L.) Kuhn Anthospermum galioides Reichenb. f. subsp. reflexi. Protea neriifolia R. Br. Erica versicolor Wendl. Lobelia coronopifolia L. Ursinia hispida (DC.) N.E. Br. Corymbium glabrum L. var. glabrum Mimetes cucullatus (L.) R. Br. Rhodocoma fruticosa (Thunb.) Linder Psoralea azurea Stirton Senecio pinifolius (L.) Lam.	2 2 + .++11+1 1.1+ +2112111 . 21 11+.R . + . 11 1+2+1 +. + 1+1 .1++ + .++ + .+ 11 1.1++1+++ 11. 11.1 ++ +.11111211+1+. 22212+. 2232 R . . + + 1+ .+ . . + 1 . + 1 .++ + R+ .1 4 . ++1 . + +.++ + + . + + 1+ . 1+ .10 1 ++ +1. +. +.1 +1 .++1+111111.1 2R+.1++ + + . + + 1R . R . + . 231.++ .221 + R23. 25 . + + . + +2 2 . + OR. + . .1 0. + +2. . +0 . 0 . R +1+ + +R+ . .++ + . R . . R . R . . + + + . + + + + . + +1 11+R.+ 222 1. . ++ . . . +++ 11 .0 + . + 1 1 . 1 + . R .10 + 01 0. 1. 2+ 2. . 0 1 0 .+11 + . . 0 .++ ++. +R +1 ++. . .1+22+1+10 .+++ 21.+ +21 ++1 . 1 +. + 1+ . 1 +1+22+1+10 .+++ 21.+ +21 . . . + . . + + +. 1 0+ . +++ . +0
Widespread species common to the majority of communities	
Erica hispidula L. Bobartia macrospatha Bak. subsp. macrospatha Schizaea pectinata (L.) Sw. Myrica kraussiana Buching ex Meisn.	1 .++11OR .+ +2+ 2+.++OR +R41 +.322 1++R12.1+ +. .22 2221 .232+23. ++ R .+ +R1+ .++R+ R+ ++. ++ +++++. R+ +.11 ++ + .2 2+11. R+ R . . + R R. .++ R +R .+R + +.R RRRRR+. + . 0 RO . . + . . + . 1 +. +. .R + .+++

the Langeberg mountain range. A small population of the rare Langeberg endemic species *Empleurum fragrans* (Rutaceae) was also located close to plot 298 but not in the *Erica hispidula*–*Brumia alopecuroides* Shrubland; this represents a range extension of some 30 km east of its previously recorded range (Williams 1984). *Leucadendron radiatum* (Proteaceae), also a Langeberg endemic, is found on rocky promontories amongst the more uniform *Erica hispidula*–*Brumia alopecuroides* Shrubland.



FIGURE 5.—The *Erica hispidula*–*Brumia alopecuroides* Shrublands on the high altitude south-facing slopes of Korinteberg.

1.2 *Erica hispidula*–*Restio inconspicuus* Shrublands

This community, similar to the shrublands of the same name in BWA, comprises most of the shrublands where *Restio inconspicuus* is present. *R. inconspicuus* is not found in the *Erica hispidula*–*Brumia alopecuroides* Shrublands and is sparingly present in the *Tetraria bromoides*–*Berzelia galpinii* Shrublands (Table 2). The *Erica hispidula*–*Restio inconspicuus* Shrublands described here were sampled on the southern mid- to lower slopes of the Bergfontein area and are characterized by presence of *Agapanthus africanus*, *Berzelia galpinii*, *Nevillea* sp. nov. (Restionaceae) (newly discovered in the Bergfontein area) amongst other species (Table 2).

Penaea cneorum subsp. *ovata*, *Leucadendron spissifolium* and *Drosera aliciae*, all species which prefer moist slopes, occur in the *Erica hispidula*–*Brumia alopecuroides* Shrublands and the *Erica hispidula*–*Restio inconspicuus* Shrublands.

1.2.1 *Restio inconspicuus*–*Chondropetalum mucronatum* Shrublands

Differential species: *Chondropetalum mucronatum*, *Chironia jasminoides*.

Dominant species: *Blaeria coccinea*, *Platycarpos compressus*, *Restio inconspicuus*.

Structural formation: Closed Graminoid Shrubland.

Relationships: *Chondropetalum*–*Restio* Tussock Marsh (Boucher 1978); ‘Slope-type’ Restioid Marsh (Taylor 1978); *Erica mollis* Fynbos Community (Glyphis *et al.* 1978); *Restio*–*Hypolaena* Subcommunity (Laidler *et al.* 1978); Restiad Herblands (in part) (Kruger 1979); Sneeu-

TABLE 2.—A phytosociological table of the *Cullumia aculeata* var. *aculeata* Shrublands on the north slopes of Witelsberg (Bergfontein) and Phesantfontein, southern Langeberg

	Community				
	3.1		3.2		
	L	M	N	O	P
Altitude (m)	88776.6665.55.5555.4455 46873.3209.33.2664.7720 84866.0161.00.1015.0610				
Aspect (°)	1 . .31. . 1 340 .3644.26.4234. 531 65008.2435.55.0000.5030				
Slope (°)	22213.111. .2212. 111 66082.1924.68.8164.8944				
Relevé number	22222*2222*22*2222*2222 88888*9999*99*7788*8888 67890*1234*56*8901*2345				
Differential species of the Protea neriifolia--Merxmüllera decora Shrublands					
Merxmüllera decora (Nees) Conert	221				R
Ischyrolepis 287/29	++ 1				
Ficinia trichodes (Schr.) Benth. & Hook. f.	+ R				
Differential species of the Protea neriifolia--Erica articularis Shrublands					
Ischyrolepis sieberi (Kunth) Linder		+1			
Euryops abrotanifolius (L.) DC.		RR			
Aristea racemosa Bak.		RR			
Zygophyllum fulvum L.		R +			
Erica articularis L.		++			
Coelidium cymbifolium C.A. Sm.		RR			
Cassytha ciliolata Nees		D			
Lobelia coronopifolia L.	R	R			
Species common to Communities 3.1.1.1 & 3.1.1.2					
Protea neriifolia R. Br.	11+21.RR+R				
Otholobium sp. 2	+1+ .+1+				
Hypodiscus albo-aristatus (Nees) Mast.	1 2+ .R1				
Thamnochortus cinereus Linder	++++. +				
Tetraria fasciata (Rottb.) C.B. Cl.	01 .1				
Phyllis imberbis Berg.	1	R			
Tetraria pillansii Levyns	+. R				
Phyllis pinea Thunb.	1.R+				
Differential species of the Leucadendron eucalyptifolium--Elegia filacea Shrublands					
Elegia filacea Mast.			24		
Hypodiscus laevigatus (Kunth) Linder			11		
Calopsis filiformis (Mast.) Linder			+		
Brunia laevis Thunb.			R		
Species common to Communities 3.1.1.2 & 3.1.2					
Centella stenophylla Adamson		RR++.			
Erica plukenetii L.		+ ++. 1			
Species common to Communities 3.1.1.1, 3.1.1.2 & 3.1.2					
Leucadendron eucalyptifolium Buek. ex Meisn.	+131+.R+0. +				
Ceratocaryum decipiens (N.E. Br.) Linder	2 1.2220.+				
Anomalanthus scoparius Klotzsch	21.22 +2				
Staberoha cernua (L.f.) Dur. & Schinz.	22 .222 .1				
Ficinia albicans Nees	R . .R				
Senecio pinifolius (L.) Lam.	++R . .RR				
Differential species of the Protea lorifolia--Ficinia lacineata Shrublands (3.2.1)					
Gnidia francisci H.Bol.				R+0+	
Polygala refracta DC.				+ OR	
Thesium subnudum Sond. 107/13				++	
Oodonaea angustifolia L.f.				+++	
Syncarpha milleflora (L.f.) B. Nord.				+R+	
Cannomois parviflora (Thunb.) Pillans				+2	
Siphocodon cf. spartioides Turcz. 47/2				R R	
Othonna sp. 278/26				1+ +	
Linum gracile Planch.				R +	
Ficinia lacineata T. Arnold				+111	
Relevé number					
22222*2222*22*2222*2222 88888*9999*99*7788*8888 67890*1234*56*8901*2345					
Species common to Communities 3.1.1.1 & 3.1.2					
Schizaea pectinata (L.) Sw.		R R . . R			
Minetes cucullatus (L.) R. Br.		2 1+ . . 1			
Anthospermum galioides Reichenb. f. subsp. reflexi		+ R . . .+1++			
Rafnia capensis (L.) Oruce		0 . . .1+ 1			
Species common to Communities 3.1.1.2 & 3.2.1					
Erica cerinthoides L.				. +. . R+0	
Phaenocoma prolifera (L.) D. Don				. +. . + ++	
Osteospermum junceum Berg.				. +. . +	
Hermannia angularis Jacq.				. 0 . R	
Species common to Communities 3.1.1.1, 3.1.1.2, 3.1.2 & 3.2.1					
Masterniella purpurea (Pillans) Linder				.2+12. 0. +22	
Aspalathus crassiseptala R. Oahlg.				+ . 1 . 0 . 11++	
Gerbera serrata (Thunb.) Oruce				RR .RRR0.R . + ++	
Metastasis pungens D. Don				++ .+ . R . 0 R	
Hypodiscus argenteus (Thunb.) Mast.				22212. R . 1.11 1	
Pentastichis colorata (Steud.) Stapf				1.1+1+ . R.2211	
Species common to Communities 3.1.1.1, 3.1.1.2 & 3.2.1					
Struthiola garciana C.H. Wright				+0 .R RR. . + ++	
Thesium carinatum A. DC.				+++ . R+1. . +	
Gnidia galpinii C.H. Wr.				1+++ .RR . . + +1+	
Thesium virgatum				+ R+ . + . R+	
Euclea polyandra (L.f.) E. Mey ex Hiern.				+ . . . + + +	
Differential species of the Protea lorifolia--Leucospermum calligerum Shrublands (3.2.2)					
Thamnochortus karooica Linder				. . . . 1 0	
Lightfootia rigida Adamson			 ++	
Machairophyllum cookii (L. Bol.) Schwantes				. . . . 111+	
Anthospermum spathulatum Sprengel subsp. spathulatu			 + + +	
Metastasis massonii S. Moore				. . . . + 1+	
Cliffortia pulchella L.f.				. . . . 0+1	
Calopsis rigida (Mast.) Linder				. . . . + 2	
Calopsis marlothii (Pillans) Linder			 + +	
Heterolepis sp. nov.			 + +	
Hermannia odorata Ait				. . . . +R	
Passerina obtusifolia Thoday				. . . . 2	
Adromischus triflorus (L.f.) Berger			 +	
Phyllis purpurea Sond. var. floccosa Pillans				. . . . 2+	
Pentastichis malouinensis (Steud.) Clayton			 +	
Clusia laxa Eckl. ex Sond.			 +	
Montinia caryophyllacea Thunb.				. . . . 0	
Cymbopogon marginatus (Steud.) Stapf ex Burtt Davy				. . . . 1	
Species common to Communities 3.2.1 & 3.2.2					
Selago dregei Rolfe				. . . . 0 . R	
Helichrysum zwartbergense H. Bol.				. . . . 0 0 0	
Lobelia linearis Thunb.				. . . . R 0 .	
Nenax acerosa Gaertn. subsp. acerosa				+ . . . +1+.R	
Species common to Communities 3.1.2 & 3.2.2					
Leucospermum calligerum (Salisb. ex Knight) Rourke				. . . . +. . 1211	
Ficinia filiformis (Lam.) Schr.				. . . . RR. . + + + +	
Stoebe microphylla DC.				. . . . R. . 1+	
Acmadenia nivenii Sond.			 + . +	
Senecio paniculatus Berg.				. . . . R . .RRR	
Elytropappus rhinocerotis (L.f.) Less.				. . . . R . . 1	
Species common to Communities 3.1.2, 3.2.1 & 3.2.2					
Protea lorifolia (Salisb. ex Knight) Fourcade				. . . . 1.+10+.1++	
Lachnaea penicillata Meisn.				. . . . 1+. . +	
Species common to Communities 3.1.1.2, 3.1.2 & 3.2.2					
Thamnochortus ellipticus Pillans				1+1+.+. . + +	
Paranome spathulatus (Thunb.) O. Kuntze				2 . 1. . 11 2	
Protea aspera Phil.				2 1+.+. . +	
Pelargonium tricolor Curt.				+.+. . R RR	
Thoracosperma galpinii 97/23				03 .+. . 1+24	

TABLE 2.—A phytosociological table of the *Cullumia aculeata* var. *aculeata* Shrublands on the north slopes of Witselsberg (Bergfontein) and Phesantfontein, southern Langeberg (continued)

Relevé number	22222*2222*22*2222*2222 88889*9999*99*788*8888 67890*1234*56*8901*2345	Relevé number	22222*2222*22*2222*2222 88889*9999*99*788*8888 67890*1234*56*8901*2345
Species common to Communities 3.1.1.1, 3.1.1.2, 3.1.2 & 3.2.2		Species common to Communities 3.1.1.2, 3.1.2, 3.2.1 & 3.2.2	
<i>Restio filiformis</i> Poir. <i>Erica versicolor</i> Wendl.	111 .1+21.2 . . + 1.RR .0+. .0 R+	<i>Protea repens</i> (L.) L. <i>Hypodiscus striatus</i> (Kunth) Mast. <i>Oedera imbricata</i> Lam. <i>Leucadendron salignum</i> Berg. <i>Rhodocoma fruticosa</i> (Thunb.) Linder	R+.31.2 .011 22.2 .1+1 .+211 + .R .+R+. +R 122+.11.222.1 R+. R. + + .11++
Species common to Communities 3.1.1.2, 3.2.1 & 3.2.2		Species common to Communities 3.1.1.2 & 3.2.2	
<i>Willdenowia bolusii</i> Pillans <i>Syncarpha paniculata</i> (L.) B. Nord. <i>Aspalathus acanthes</i> Eckl. & Zeyh. <i>Elegia galpinii</i> N.E. Br. <i>Lightfootia fasciculata</i> (L.f.) A. DC.	. +. . . +.2211 R .+R+. .+22+. + . 1+. .+1.R R 4 .+321. .0 .213 .RR +. .+R . R	<i>Centella virgata</i> (L.f.) Drude var. <i>virgata</i> <i>Pelargonium fruticosum</i> (Cav.) Willd. <i>Crassula atropurpurea</i> (Haw.) Oietr. var. <i>atropurpu</i>	+. . . .0 +. . . .RR +. . . .1
Species common to Communities 3.1.1.1, 3.1.1.2 & 3.2.1		Widespread species common to all communities	
<i>Osteospermum triquetrum</i> L.f. <i>Leucospermum cuneiforme</i> (Burm. f.) Rourke <i>Tetralia cuspidata</i> (Rottb.) C.B. Cl. <i>Muraltia ciliaris</i> DC. <i>Bobartia macrocarpa</i> Bak. subsp. <i>macrocarpa</i> <i>Lanaria lanata</i> (L.) Our. & Schinz. <i>Metalasia galpinii</i> (L.) Bol. <i>Tetralia crassa</i> Levyns	1+++ .0+ . .+11+. + 11+R . + . .1 . + +1+ .+12. .+111.+ R + . R+. .+R+. + R R R R . .R R+. + 12112.21+1. .+R+. +1+ 2. +1. .1 +. + 11+ . +0. . . .+ +	<i>Willdenowia glomerata</i> (Thunb.) Linder <i>Hypodiscus aristatus</i> (Thunb.) Krauss <i>Cullumia aculeata</i> (Houtt.) Roessl. var. <i>aculeata</i> <i>Corymbium glabrum</i> L. var. <i>glabrum</i> <i>Restio triticeus</i> Rottb. <i>Tetralia ustulata</i> (L.) C.B. Cl.	1 ++ .+0+R+.R+. +. 0 21 +. .1+1.2111.1+ + + .0+++0 .1++ .+R+. + 1 +. +1 .R . .+R+. + ++ 11. ++++.+1+1. + 2 2. 2. 2.3323.+1+1

kop Azonal Restioid Fynbos (Campbell 1985); *Restio inconspicuus*–*Anthochortus crinalis* Shrublands (McDonald 1993a); *Erica hispidula*–*Anthochortus crinalis* Shrublands (McDonald 1993b).

Chondropetalum mucronatum is widely distributed from the eastern Langeberg to Bainskloof and the Cape Peninsula in marshy places (Linder 1985). In the Cape Hangklip area Boucher (1978) records it as occurring on mountain slopes at sites with impeded drainage irrespective of aspect or altitude. This is similarly true on the Langeberg, however, at BWA and MNR (McDonald 1993a & b), stands of *C. mucronatum* are scattered and simply form part of the vegetation mosaic on south-facing wet slopes. At Bergfontein the distribution of *C. mucronatum* is not so scattered and the species differentiates a distinct community on localized seepages with a ‘peaty coarse sand’ substratum as it does in the Cape Hangklip mountains (Boucher 1978). *Chironia jasmynoides* is also characteristic of marshy places from the southwestern Cape to the Riversdale District (Bond & Goldblatt 1984) and at Bergfontein, is almost at the eastern limit of its range.

At Bergfontein the *Restio inconspicuus*–*Chondropetalum mucronatum* Shrublands (Figure 6) occur within an altitudinal range from 560 m to 850 m on moderate slopes (14°–30°) with southeast- to southwest-facing aspects.

This community has an upper stratum dominated by *Chondropetalum mucronatum* (up to 1.5 m) which emerges above a low closed stratum (<0.5 m) where grasses, restios and ericas are present in more or less equal proportions. *Blaeria coccinea* (Ericaceae) is the dominant shrub with *Platyaucos compressus* and *Restio inconspicuus* (Restionaceae) and *Pentameris macrocalycina* and *Pentameris malouinensis* (Poaceae) comprising the major part of the graminoid component. The *Nevillea* sp. nov. recorded here is closely allied to the *N. obtusissima*

recorded by Boucher (1978) in the *Chondropetalum*–*Restio* Tussock Marsh of the Cape Hangklip area.

1.2.2 *Restio inconspicuus*–*Selago serrata* Shrublands

Differential species: *Othonna quinqueidentata*, *Selago serrata*, *Syncarpha vestita*.

Dominant species: *Elegia juncea*, *Leucadendron spissifolium*, *Pentameris macrocalycina*, *Pentaschistis malouinensis*, *Restio inconspicuus*, *Staberoha cernua*.

Structural formation: Low Open to Closed Graminoid Shrubland with sparse emergent shrubs.

Relationships: *Tetralia thermalis*–*Hypodiscus aristatus* Community (Kruger 1974); *Leptocarpus membranaceus* (*Calopsis membranacea*)–*Hypodiscus aristatus* Commu-



FIGURE 6.—The *Restio inconspicuus*–*Chondropetalum mucronatum* Shrublands on southeast- to southwest-facing slopes at Bergfontein.

nity (McKenzie *et al.* 1977); Subcommunity C of the *Penaea-Erica* Fynbos Community (Glyphis *et al.* 1978); Low Ericoid Open Heath or Open graminoid-heath (Kruger 1979); *Erica viridescens-Hypodiscus aristatus* Community (Bond 1981); Nuweberg Mesic Ericaceous Fynbos (Campbell 1985); *Hypodiscus aristatus-Berzelia intermedia* Shrublands (McDonald 1993a).

This community (Figure 7) is found on east- to south-west-facing rocky sites where surface rock was estimated at 32% on average. Slope inclination ranges from 17°–37° and the sandy Mispah Form soils (lithosols) are well drained. In general this shrubland has a single low stratum (<1 m) with *Psoralea pinnata* occasionally emergent to 2 m.

This shrubland community is poorly differentiated. It has only three character species, *Othonna quinquedentata*, *Selago serrata* and *Syncarpha vestita* which are poorly represented. It lacks the moisture-loving species common to communities 1.1 and 1.2.1 but has a strong graminoid component, a characteristic which it shares with the *Restio inconspicuus-Chondropetalum mucronatum* Shrubland. Apart from the dominant species, *Calopsis membranacea* and *Hypodiscus aristatus* (Restionaceae) are well represented, whereas *Berzelia galpinii* is not prominent. The low cover-abundance of *Berzelia galpinii* is ascribed to the shallow, rocky, well-drained nature of the soil.

1.2.3 *Restio inconspicuus-Erica melanthera* Shrublands

Differential species: none.

Dominant species: *Berzelia galpinii*, *Elegia asperiflora*, *Erica cubica*, *Pentastichis maloninensis*, *Staberoha cernua*, *Tetraria flexuosa*.

Structural formation: Low Closed Graminoid Shrubland.



FIGURE 7.—The *Restio inconspicuus-Selago serrata* Shrublands found on rocky sites with east- to southwest-facing aspects above Bergfontein.



FIGURE 8.—The *Restio inconspicuus-Erica melanthera* Shrublands on grey shallow sandy lithosols at Bergfontein.

Relationships: as for 1.2.2 above but *Berzelia intermedia-Erica melanthera* Shrublands (McDonald 1993a) and *Leucadendron eucalyptifolium-Erica melanthera* Shrublands (McDonald 1993b).

This community (Figure 8) is found on a variety of aspects from northeast through south to southwest. The soils are grey sandy shallow lithosols, seldom exceeding 0.3 m and mostly <0.2 m deep. Amounts of exposed rock range from very low to 98% with most sample sites having 85% rock cover. Despite this, total vegetation cover is high at 94%.

The absence of differential species in this community is apparently related to the drainage régime. Species such as *Berzelia galpinii*, *Erica cubica* and *Elegia asperiflora* which have a strong preference for sites with impeded drainage, although occurring in other communities, play a dominant role here. *Erica melanthera* which favours shallow sandy soils is also mainly found in these shrublands, but this species is generally much less common than in the *Hypodiscus aristatus-Berzelia intermedia* Shrublands of BWA (McDonald 1993a).

The low stature of the community is ascribed to the shallowness of the soil and high percentage rock cover. It could be speculated, however, that some stands would reach mid-high to tall stature in older vegetation.

1.3 *Erica hispidula-Tetraria bromoides* Shrublands

These shrublands include five distinct communities that have *T. bromoides* as the common denominator. *T. bromoides* (Cyperaceae) is a robust leafy sedge that is known for its preference for heavier soils i.e. soils with a high clay fraction, derived from shale or sandstone (Boucher 1978; McDonald 1993a & b). Of note is the occurrence of *Penaea mucronata* in these shrublands. This species shows a distinctly different habitat preference (lower, drier slopes) to *Penaea cneorum* subsp. *ovata*

which is found in communities of the *Erica hispidula*–*Restio inconspicuus* Shrublands on wetter, higher slopes.

1.3.1 *Tetraria bromoides*–*Berzelia galpinii* Shrublands

Differential species: none.

Dominant species: *Erica hispidula*, *Leucadendron eucalyptifolium*, *Penaea utronata*, *Tetraria flexuosa*.

Structural formation: Low Closed Graminoid Shrubland with Mid-high Emergent Shrubs in some stands.

Relationships: *Berzelia*–*Leucadendron* Moist Tall Fynbos (Boucher 1978); Mixed-sclerophyllous Scrub (Kruger 1979); Mangold Wet Proteoid Fynbos (Campbell 1985).

This community (Figure 9) is found on south and southwest-facing slopes at altitudes ranging from 350–550 m. Soils are derived from sandstone of either the Peninsula Formation or Nardouw Subgroup and are generally 0.5 m deep, with soils at some sites as shallow as 0.1 m. The average slope of sampled stands is 21.3° (8°–32°). Rockiness is generally low, with an average of 12%, but with some sites having as much as 90% surface rock. Amount of litter depended on the age of the stand, with the old vegetation having an estimated 75% litter cover below the shrub canopy.

Two of the stands sampled (relevés 212 & 213) of the community were located in vegetation estimated to be 16 years or possibly older. The remainder of the samples were in six-year-old vegetation. The two mature stands gave a clear indication of how the *Tetraria bromoides*–*Berzelia galpinii* Shrublands would appear over a much wider area when mature. In the mature state they would be classified structurally as Tall Closed Proteoid Shrublands with a Closed Ericoid Shrubland Understorey, in contrast with the structural formation given above.

The *Tetraria bromoides*–*Berzelia galpinii* Shrublands are transitional between the *Erica hispidula*–*Restio in-*

conspicuus Shrublands on shallow sandy soils and the *Erica hispidula*–*Tetraria bromoides* Shrublands on soils with a high clay fraction derived either from shale or an admixture of sandstone and shale. Since the *Tetraria bromoides*–*Berzelia galpinii* Shrublands are ecotonal their floristic composition is complex, displaying elements of both the *Erica hispidula* Shrubland types given above (Table 1).

1.3.2 *Tetraria bromoides*–*Ischyrolepis hystrix* Shrublands

The two communities found on the Cedarberg Formation shaleband, the *Tetraria bromoides*–*Phlylica rubra* and *Tetraria bromoides*–*Knowltonia capensis* Shrublands have many species in common but also a number of differences (discussed below). However, the absence of many species from these communities which are otherwise generally found in the *Erica hispidula*–*Tetraria bromoides* Shrublands sets these shrublands apart. These distinctions are ascribed to soil-related rather than climate-related factors.

1.3.2.1 *Ischyrolepis hystrix*–*Phlylica rubra* Shrublands

Differential species: *Cyclopia sessiliflora*, *Indigofera samentosa*, *Phlylica rubra*.

Dominant species: *Ischyrolepis hystrix*, *Leucadendron eucalyptifolium*, *Phlylica rubra*, *Protea aurea*, *P. neriifolia*, *Tetraria bromoides*.

Structural formation: Tall Proteoid Shrubland with Mid-high, Mid-dense Shrub Understorey and Low Mid-dense Graminoid Field Layer.

Relationships: Broad-sclerophyllous Scrub (Kruger 1979); *Protea aurea*–*Pteridium aquilinum* Community (Bond 1981); Outeniqua Wet Proteoid Fynbos (Campbell 1985); *Restio inconspicuus*–*Protea aurea* Shrublands (McDonald 1993a); *Cliffortia serpyllifolia*–*Leucadendron eucalyptifolium* Shrublands and *Widdringtonia nodiflora*–*Tetraria bromoides* Shrublands (McDonald 1993b).

The *Ischyrolepis hystrix*–*Phlylica rubra* Shrublands (Figure 10) were sampled on the Cedarberg Formation shaleband, east of Stinkhoutbos, behind Korinteborg. The mean altitude of the sample sites (relevés 301–304), which were located relatively close to each other in mature proteoid fynbos, is 824.5 m. Aspect ranged from southwest to west on shallow (5°) to moderate (22°) slopes. The yellow-brown sandy clay loam soils are classified as Clovelly Form, reaching a mean depth of 0.45 m. Surface rock cover is low, not exceeding 10% and the soils are moderately to well drained. Litter cover is high (60–80%) and the shrub canopy cover is closed (100%).

The age of the *Ischyrolepis hystrix*–*Phlylica rubra* Shrublands, estimated at 15 years, could be a factor influencing the difference in species composition between this community and the closely allied but younger *Ischyrolepis hystrix*–*Phlylica pinea* Shrublands found at Bergfontein (see below). Alternatively it may be postulated that geographical separation of the two areas where the shrublands were sampled may account for the differences between them (gamma diversity). These two shrublands may also be interpreted as variants of a broader shaleband community dominated by *Cannomois virgata*, *Erica grata*, *Ischyrolepis hystrix*, *Phlylica pinea* and *Protea*



FIGURE 9.—The *Tetraria bromoides*–*Berzelia galpinii* Shrublands found on southerly slopes with sandy soils at altitudes from 350–550 m.



FIGURE 10.—The *Ischyrolepis hystrix*–*Phylica rubra* Shrublands found on the Cedarberg Formation shaleband east of Stinkhoutbos. Note the tall *Protea aurea* shrubs behind the figure.

aurea, since *P. aurea* and *Tetraria bromoides* dominated shaleband shrublands have been recorded in other parts of the Langeberg (McDonald 1993a & b). As much as the differential species separate the above two communities from each other, absence of numerous species, the most notable of which are *Gnidia galpinii*, *Lanaria lanata*, *Penaea mucronata* and *Struthiola garciana*, reinforce the distinction between the two shrublands (Table 2).

1.3.2.2 *Ischyrolepis hystrix*–*Phylica pinea* Shrublands

Differential species: *Carpacoea spermacoea*, *Erica coccinea*, *Knowltonia capensis*, *Pelargonium cordifolium*, *Serruria fasciflora*.

Dominant species: *Cannomois virgata*, *Ischyrolepis hystrix*, *Leucadendron eucalyptifolium*, *Phylica pinea*.

Structural formation: Tall Mid-dense to Closed Restioid/Proteoid Shrubland with Sparse Mid-high Shrub Understorey and a Low Mid-dense to Closed Graminoid Shrubland field layer.

Relationships: as for 1.3.2.1 above.

Apart from relevé 227, samples representing the *Ischyrolepis hystrix*–*Phylica pinea* Shrublands (Figure 11) were found at altitudes from 300–400 m on southeast- to southwest-facing slopes of the Cedarberg Formation shaleband, where it traverses the Bergfontein area. Relevé 227 was sampled on a shale lens on a moderate north-west-facing slope above Rooiwaterspruit, where the soil is a 0.3 m deep, yellow-brown loamy Clovelly Form soil. The soils at Bergfontein were not classified except that they were noted to have a grey-brown orthic A-horizon.

At Rooiwaterspruit, the vegetation in relevé 227 was dominated by *Leucadendron eucalyptifolium* in the tall (1.5–3.0 m) mid-dense canopy. Non-ericoid shrubs and graminoids combined to form a closed understorey, 1.5 m high. The community represented by relevé 227 is

somewhat different to the Bergfontein Community since many of the typical shaleband-associated species are absent (Table 2). However, it is similar enough to the *Ischyrolepis hystrix*–*Knowltonia capensis* Shrublands and different enough from the *Ischyrolepis hystrix*–*Phylica rubra* Shrublands for it to be included in the former. The community at Bergfontein was dominated by the tall (1.2–5.0 m) *Cannomois virgata* in the canopy, with a mid-high, mid-dense stratum dominated by *Phylica pinea* and *Protea aurea* and a low, closed stratum dominated by restioids.

The *Ischyrolepis hystrix*–*Phylica pinea* Shrubland is the only community from which *Erica hispidula* is totally absent. No explanation for this can be advanced since this species occurs in similar communities in the MNR and BWA (McDonald 1993a & b). A combination of wetness and shale-derived soil may account for the absence of this species.

1.3.3 *Tetraria bromoides*–*Hypodiscus striatus* Shrublands

Differential species: *Anomalanthus scoparius*, *Diosma tenella*, *Heteropogon contortus*, *Hypodiscus striatus*, *Peucedanum ferulaceum*, *Polygala* sp.

Dominant species: *Anomalanthus scoparius*, *Erica hispidula*, *Hypodiscus striatus*, *Lanaria lanata*, *Leucadendron eucalyptifolium*, *L. salignum*, *Tetraria bromoides*.

Structural formation: Low Mid-dense to Closed Graminoid Shrubland with Mid-high to Tall, Sparse to Mid-dense Proteoid Shrubland Overstorey.

Relationships: Mixed-sclerophyllous Scrub (Kruger 1979); *Protea neriifolia*–*Leucadendron eucalyptifolium*–*Erica triceps* Community (Bond 1981); Robinson Mesic Proteoid Fynbos (Campbell 1985); *Hypodiscus aristatus*–*Leucadendron eucalyptifolium* Shrublands (McDonald 1993a); *Leucadendron eucalyptifolium*–*Erica melanthera* Shrublands (McDonald 1993b).



FIGURE 11.—The *Ischyrolepis hystrix*–*Phylica pinea* on the Cedarberg Formation shaleband in the Bergfontein area. Note the tall restio, *Cannomois virgata*, characteristic of this community.

These shrublands (Figure 12) were sampled on the north and northwest slopes of Koksposberg and on the west-facing mid-slopes of Witelsberg, overlooking Witelsrivier (Bergfontein area). The community occurs at altitudes from 300–550 m on sites with shallow (0.2 m) well-drained sandy loam soils, where the slopes are moderate to steep (16°–36°) and where rock cover varies from almost nil to 90%.

Presence of *Tetraria bromoides* points to soils with a higher fertility, however, soil-vegetation relationships of this community are not clear and require further investigation. The community is clearly defined and characterized by differential species (Table 1) which have a preference for stony or rocky well-drained sites. All the differential species are also species of low stature which are found in the understorey of mature stands of the *Tetraria bromoides*–*Hypodiscus striatus* Shrublands. *Anomalanthus scoparius* (Ericaceae) grows as a prostrate dwarf shrub covering stony soil but not over rocks (E.G.H. Oliver pers. comm.) and the erect *Hypodiscus striatus* (Restionaceae) is found as tussocks in shallow pockets of soil. *Heteropogon contortus* is a subtropical C₄ grass which Bond (1981) recorded as differential for his *Protea nitida* Community (Waboomveld) on fertile soils. At Bergfontein, *H. contortus* is faithful to the *Tetraria bromoides*–*Hypodiscus aristatus* Shrublands and not found at all in the *Erica hispidula*–*Protea nitida* Shrublands described below. *Diosma tenella* (Rutaceae) is a shrublet which Williams (1982) described as 'rather rare' but having a wide tolerance for different soil types, from shales to sandy gravels and silcrete.

From Table 1 it is seen that there are numerous species which, although not differential or dominant, are strongly represented in this community: *Acmadenia trigona*, *Leucadendron salignum*, *Lanaria lanata*, *Penaea mucronata*, *Staberoha cernua*, *Tetraria flexuosa* and *Rhodocoma fruticosa*.

One or two strata were found in these shrublands at the time of sampling. One stratum was found where the shrubs were co-dominant with the graminoid component up to a height of 1 m. Two strata occurred where the shrubs, mainly proteoids such as *Leucadendron eucalyptifolium* and *Protea neriifolia*, exceeded 1 m, forming a sparse to mid-dense overstorey. The immaturity of the vegetation gave a false impression of the potential structure of the community, which is predicted to become a tall closed proteoid shrubland with a low closed ericoid or restioid shrubland understorey when mature (as in relevés 261 & 262).

1.3.4 *Tetraria bromoides*–*Protea coronata* Shrublands

Differential species: *Alepidea capensis*, *Erica* cf. *zwartbergense*, *Protea coronata*.

Dominant species: *Erica hispidula*, *Lanaria lanata*, *Leucadendron eucalyptifolium*, *Tetraria bromoides*.

Structural formation: Mid-high Closed Proteoid Shrubland with Low Closed Graminoid Shrubland Understorey or a Low Closed Graminoid Shrubland with Sparse emergent Proteoid shrubs.

Relationships: Broad-sclerophyllous Scrub (Kruger 1979); Outeniqua Wet Proteoid Fynbos (Campbell 1985); Wet Proteoid Fynbos (Rebello *et al.* 1991).

This community (Figure 13) occurs on the lower south-east-, southwest- and west-facing slopes of Koksposberg in the Bergfontein area. At plot 221 the soil is derived from Cedarberg Formation shale, whereas at the remainder of the plots (214–216 & 247) the soils are apparently derived from accumulated material at the footslopes. The soils are well-drained shallow (0.2–0.3 m) fine-textured grey-brown to dark brown sandy loams, with negligible surface rock cover.

The distribution of *Protea coronata* is strongly related to edaphic factors with this species favouring heavy soils with a high clay fraction (Rourke 1980). At Bergfontein, *Protea coronata* occurs on sandy loam soils but, contrary to Rourke's description where *Protea coronata* is said to form 'densely massed stands', the species occurs as scattered individuals. Frequent fires may have excluded *P. coronata*, a reseeding proteoid, at three of the five sample sites. Alternatively these sites may be marginally more mesic and *P. coronata*, which prefers wetter sites (Rourke 1980), may have been outcompeted by *Protea neriifolia* and *Leucadendron eucalyptifolium* (Table 2). Even though the *Tetraria bromoides*–*Protea coronata* Shrubland is poorly characterized by the differential species *Alepidea capensis*, *Erica* cf. *zwartbergense* and *P. coronata*, it is substantiated by absence of numerous species found in the *Tetraria bromoides*–*Hypodiscus striatus* Shrublands on the one hand and the *Tetraria bromoides*–*Protea nitida* Shrublands on the other. It also has many species in common with the latter community, in particular the ubiquitous 'waboomveld' species *Montinia caryophyllacea* and *Rhus rosularifolia*. *Helichrysum cymosum* is not a true differential species of the *Tetraria bromoides*–*Protea coronata* Community as stated by Rebello *et al.* (1991) since this species is also well represented in the more mesic *Erica*



FIGURE 12.—The *Tetraria bromoides*–*Hypodiscus striatus* Shrublands on the west-facing slopes of Koksposberg with the south slopes of Witelsberg visible behind.



FIGURE 13.—The *Tetralix bromoides*–*Protea coronata* Shrublands on the lower slopes of Koksposberg, in the Bergfontein area.

hispidula–*Protea nitida* Shrublands which were not sampled or described by these authors.

Two strata were found in these shrublands. Graminoids are marginally more abundant than woody shrubs in the low stratum, which was the dominant stratum when sampled. In relevé 247, the low stratum had been disturbed by grazing animals. The upper stratum was dominated by mid-high proteoid shrubs, *Lencadendron eucalyptifolium* and *Protea neriifolia*. Following Campbell's (1985) system, the *Tetralix bromoides*–*Protea coronata* Shrublands would be placed in the Mesic Proteoid Subseries, however, based on floristic composition and relationships, the community is placed unequivocally in Wet Proteoid Fynbos.

Aloe gracilis Haw. var. *decumbens* Reynolds was found in this community and the *Erica hispidula*–*Protea nitida* Shrublands. Reynolds (1950) gives the distribution of this endemic variety of *Aloe gracilis* as from near Garcia's Pass westwards to Kleinberg at altitudes 272–364 m. Records of *A. gracilis* var. *decumbens* at Bergfontein represents a range extension for this species on the Langeberg, 30 km east of Garcia's Pass. Future searches could reveal that it may occur further east, perhaps beyond the Gounitz River.

1.4 *Erica hispidula*–*Protea nitida* Shrublands

Differential species: *Anthospermum aethiopicum*, *Calopsis filiformis*, *Clusia laxa*, *Eragrostis capensis*, *Erica glandulosa*, *E. peltata*, *Pelargonium candicans*, *Protasparagus rubicundus*, *Protea nitida*, *Themeda triandra*.

Dominant species: *Lanaria lanata*, *Lencadendron salignum*, *Protea nitida*, *Restio triticeus*, *Themeda triandra*.

Structural formation: Closed Graminoid Shrubland with Mid-high Sparse to Open Proteoid Overstorey.

Relationships: 'Waboomveld' (Taylor 1963, 1978; Taylor & Van der Meulen 1981); *Protea arborea* (*P. nitida*)

Pseudo-Savannah (Taylor 1969); *Protea arborea*–*Rhus angustifolia* Community (Werger *et al.* 1972); *Protea–Tetralix* Dry Short Fynbos (Boucher 1978); *Restio gaudichaudianus* (*Ischyrolepis gaudichaudiana*)–*Lobostemon glaucophyllus* Community (McKenzie *et al.* 1977); *Protea arborea* (*P. nitida*) Tall Broad-sclerophyllous Shrubland or Open Shrubland with Heathland (Kruger 1979); *Protea nitida* Community (Waboomveld) [Outeniqua Mountains] & *Protea nitida*–*Protea repens* Community [Swartberg] (Bond 1981); *Protea nitida* Woodland ('Waboomveld') (Taylor 1984); Rooiberg Talus Asteraceous Fynbos (Campbell 1985); *Ischyrolepis gaudichaudiana*–*Myrsine africana* High Closed Shrubland (McDonald 1983, 1988).

Protea nitida is most often found on colluvial soils on debris or talus slopes but may also be found on fine-textured soils on lower mountain slopes (Taylor 1978; Kruger 1979; R.M. Cowling pers. comm.). These soils generally have a higher nutrient status than that of leached sandstone soils, due to colluvial mixing of soil derived from various parent materials such as sandstone, granite or shale. Fynbos with *P. nitida* as a prominent, if not dominant shrub or tree, is found throughout the Fynbos Biome and according to Taylor (1978) and Kruger (1979) characterizes a distinct formation, 'waboomveld'. The term 'waboomveld' encompasses more than one community where *P. nitida* is present, but throughout the distribution range of this species from the northwestern to the southern Cape there is a remarkably constant group of associated species including *Anthospermum aethiopicum*, *Ischyrolepis gaudichaudiana*, *Montinia caryophyllacea*, *Rhus rosmarinifolia* and *Themeda triandra*. Campbell (1985) explicitly stated that *P. nitida* is diagnostic and must be present for Mountain Fynbos to be classified as Talus Asteraceous Fynbos but he also indicated that *P. nitida* occurs in other communities as well.

At Bergfontein these shrublands (Figure 14) have either two or three strata. *P. nitida* forms a sparse canopy up to 2 m high. Where present the second stratum from 0.5–1.2 m is dominated by *Lencadendron salignum* and the low stratum 0.0–0.5 m by *Themeda triandra*. The community was restricted to well-drained east-facing slopes above Witelsrivier, directly opposite the west-facing slopes of Koksposberg where the closely related *Tetralix bromoides*–*Protea coronata* Shrublands occur. The altitude at which these shrublands are found ranges from 300–350 m with the slopes averaging 19°. Annual precipitation is estimated at 600–700 mm (Dent *et al.* 1987). The soils with pH 4.9 ($n = 3$) are a shallow (0.2 m) well-drained mix of sandstone debris from the Peninsula Formation sandstone and Cedarberg Formation shale. They are classified as Oakleaf Form soils. Rock cover ranges from 10–40%.

Apparently the *Erica hispidula*–*Protea nitida* Shrublands at Bergfontein are not burnt often, so the composition of the understorey is not attributed to regular fires or other disturbances. The grassy understorey is rather attributed to soil factors since the grasses in the community are C4 grasses which show preference for more fertile soils (Bond 1981; Cowling 1983a & b; Linder 1989). This community qualifies for inclusion in Campbell's (1985) Rooiberg Talus Asteraceous Fynbos on the basis of presence of *Protea nitida* and 20 % grass cover. However,

the lack of asteraceous 'elytropappoid' species and the high grass cover (70%) indicate closer affinities to Grassy Fynbos (*sensu* Cowling & Holmes 1992).

A stand of tall *P. nitida* with an understorey composed almost entirely of grasses was located on deep sandy soils on the plateau below the upper north slopes of Witelsberg. This community was not sampled but was observed to be quite different in structure and composition from the *Erica hispidula*-*Protea nitida* Shrublands. Further investigation, not possible in this study due to the fire, would be required to clarify the relationships.

2. *Erica versicolor*-*Agathosma ovata* Shrublands

Differential species: *Adromischus triflorus*, *Agathosma ovata*, *Centella virgata* var. *congesta*, *Crassula atropurpurea* var. *atropurpurea*, *C. muscosa*, *C. rupestris*, *Crassula* sp. (unidentified), *Erica tenuis*, *Ficinia elongata*, *Lampranthus deltooides*, *Lobelia pubescens* var. *pubescens*, *Senecio aizoides*.

Dominant species: *Agathosma ovata*, *Ehrharta ramosa*, *Erica melanthera*, *E. versicolor*, *Phyllaea purpurea* var. *floccosa*.

Structural formation: Sparse to Open Low Graminoid Shrubland.

Relationships: unclear.

The estimated annual precipitation for Kokposberg is 500–600 mm (Dent *et al.* 1977). However, the north-facing slopes are in a rain shadow as well as being equatorially oriented. They are therefore hot and dry and probably receive much less rainfall than the above estimate. A similar situation also exists on the upper north-facing slopes of Witelsberg. These dry, rocky slopes (Figure 15) with high incoming radiation host the *Erica versicolor*-*Agathosma ovata* Shrublands. The soils are lithosols (Mispah Form), are shallow and acid (pH 3.4 in 1 mol/l CaCl₂) and consist merely of accumulated sand and organic material in shallow depressions amongst the rocks.



FIGURE 14.—The *Erica hispidula*-*Protea nitida* Shrublands on the east-facing slopes, west of Bergfontein, above Witelsrivier.



FIGURE 15.—The *Erica versicolor*-*Agathosma ovata* Shrublands found on the rocky north slopes of Kokposberg and Witelsberg.

The parent rock of Kokposberg is Peninsula Formation sandstone and rock cover is 90% in the four relevés (208–211) representing this community. On Kokposberg the community is found at altitudes from 550–606 m on slopes varying from almost flat (7°) on the ridge to moderately steep (18°) on the north face. On Witelsberg, consisting of Nardouw Subgroup sandstone, the community is found from 788 m to 1 090 m.

Two strata are present in the *Erica versicolor*-*Agathosma ovata* Shrublands. The upper stratum is from 0.5–1.2 m and is dominated by the shrubby *Erica versicolor*. The lower stratum where shrubs and graminoids are co-dominant is from 0–0.5 m. Dominant species in this stratum are *Ehrharta ramosa* and *Erica melanthera*. However, the prevalence of succulent species in the genera *Adromischus*, *Aloe*, *Crassula*, *Lampranthus* and *Senecio* which prefer dry, rocky sites gives this community its character and sets it apart from all other communities described for the Bergfontein area (relevés not included in Table 1 or Table 2). *A. ovata* also favours a dry, rocky habitat as does *Oldenburgia paradoxa* which grows in rock crevices forming large, compact, rounded masses of short shoots.

A detrended correspondence analysis (DCA) (Hill 1979b) of the Bergfontein data showed a clear distinction between the *Erica versicolor*-*Agathosma ovata* Shrubland and the other shrublands. DCA Axis I represented a moisture gradient and the *Erica versicolor*-*Agathosma ovata* Shrublands are towards the drier end of the gradient. DCA Axis II apparently represented a soil depth/rockiness gradient, showing that the community inhabits the rockiest sites with shallowest soils in the study area.

3. *Cullumia aculeata* var. *aculeata* Shrublands

The *Cullumia aculeata* Shrublands include the non-*Erica hispidula* shrublands represented by Table 2. All these shrublands are on the northern slopes of the

Langeberg range adjacent to the Little Karoo. Most of the samples were taken in the Phesantefontein area; the exceptions are relevés 278–281 which were recorded on the north slopes of Witelsberg before the May 1991 fire.

3.1 *Cullumia aculeata*–*Leucadendron eucalyptifolium* Shrublands

This community is found on the mid- to upper slopes immediately east of Aasvoëlkrans. They are mesic proteoid shrublands and are separated into three distinct communities with *Leucadendron eucalyptifolium* as the common factor.

3.1.1 *Leucadendron eucalyptifolium*–*Protea neriifolia* Shrublands

Two communities are found in the *Leucadendron eucalyptifolium*–*Protea neriifolia* Shrublands. *P. neriifolia* links these shrublands, setting them apart from the *Leucadendron eucalyptifolium*–*Elegia filacea* Shrublands where *P. neriifolia* is absent. These shrublands have affinity to the *Tetraria bromoides*–*Hypodiscus striatus* Shrublands found on the southern slopes at Bergfontein with *Anomalanthus scoparius* and *Hypodiscus striatus*, differential species of the latter community, being found here as well.

3.1.1.1 *Protea neriifolia*–*Merxmuellera decora* Shrublands

Differential species: *Ficinia trichodes*, *Ischyrolepis* sp., *Merxmuellera decora*.

Dominant species: *Hypodiscus argenteus*, *Lanaria lanata*, *Merxmuellera decora*.

Structural formation: Mid-high Closed Graminoid Shrubland.

Relationships: Proteoid Zone Fynbos (Taylor 1978); Broad sclerophyllous- Scrub or Open Scrub (Kruger 1979); Sanddrift Mesic Proteoid Fynbos (Campbell 1985); affinities with *Tetraria bromoides*–*Hypodiscus striatus* Shrublands and *Tetraria bromoides*–*Protea coronata* Shrublands described above.

This community (Figure 16) is represented by five relevés (286–290) at altitudes from 630–850 m on the northeast- to northwest-facing slopes east of Aasvoëlkrans. These slopes are moderate, with shallow (0.2 m), yellow-brown sandy loam soil, classified as Glenrosa Form. The parent material of the soil is taken to be Nardouw Subgroup sandstone, but the heavy nature of the soil (relevés 286–289) suggests a high clay fraction possibly derived from a clay lens or local exposure of the Cedarberg Formation shale. This requires verification but the vegetation reflects a soil with a relatively higher nutrient status (see below). Surface rock cover is low to moderate (3–40%) except in relevé 290 which is different from the other samples. It was located on a rocky sandstone outcrop with 95% rock cover. The soil is of the Mispah Form, but the floristic composition of the relevé places it in the *Protea neriifolia*–*Merxmuellera decora* Shrublands.

At the time of sampling, the vegetation was seven years old. Depending on the site, the community had one or two strata, with height not exceeding 1.2 m. The shrubland was thus classified as above, a Mid-high Closed Graminoid Shrubland, but it is predicted that with time the community would mature to a Tall Closed Proteoid Shrubland with a Graminoid Understorey.

The *Protea neriifolia*–*Merxmuellera decora* Shrublands are poorly differentiated from the closely allied *Protea neriifolia*–*Erica articularis* Shrublands based on the differential species of the first community. *Merxmuellera decora* presents problems with identification in mature vegetation since it usually flowers only in the immediate post-fire phase; *Ischyrolepis* sp. (Table 2) was not identified and *Ficinia trichodes* was poorly represented. Absence of the differential species of the latter community from the *Protea neriifolia*–*Merxmuellera decora* Shrublands provides a sounder basis for the separation of the two communities.

3.1.1.2 *Protea neriifolia*–*Erica articularis* Shrublands

Differential species: *Aristea racemosa*, *Cassytha ciliolata*, *Coelidium cymbifolium*, *Erica articularis*, *Euryops abrotanifolius*, *Ischyrolepis sieberi*, *Zygophyllum fulvum*.

Dominant species: *Ceratocaryum decipiens*, *Elegia galpinii*, *Leucadendron salignum*, *Staberoha cernua*.

Structural formation: Low Closed Herbland or Low Mid-dense to Closed Graminoid Shrubland.

Relationships: Proteoid Zone Fynbos (Taylor 1978); Broad-sclerophyllous Scrub or Open Scrub (Kruger 1979); *Elegia galpinii*–*Metalasia pulcherrima* Community (Outeniqua Mountains) and *Protea repens*–*Protea lorifolia*–*Hypodiscus striatus* Community (Swartberg) (Bond 1981); Mesic Mountain Fynbos (Moll *et al.* 1984); Thomas Dry Proteoid Fynbos (Campbell 1985). *Leucadendron eucalyptifolium*–*Staberolia cernua* Shrublands (McDonald 1993a).

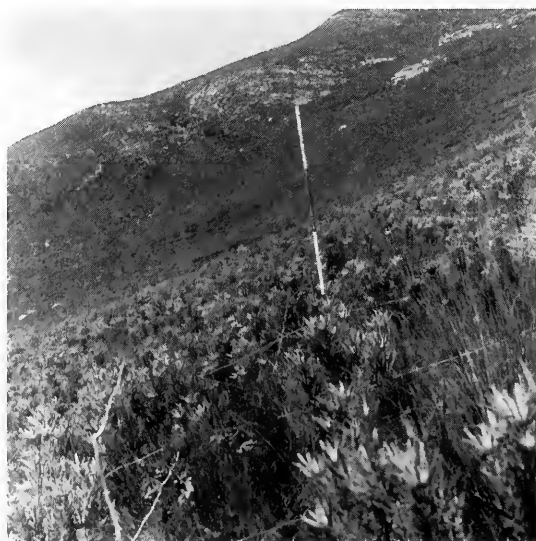


FIGURE 16.—The *Protea neriifolia*–*Merxmuellera decora* Shrublands found on the northeast- to northwest-facing slopes east of Aasvoëlkrans, above Phesantefontein.

This community (Figure 17) occurs on the same north-facing slopes as the *Protea neriifolia*–*Merxmüllera decora* Shrublands but at lower altitudes (590–630 m). The shallow (0.2–0.3 m), light grey-brown soils were classified as Glenrosa Form (relevés 291–293) and Mispah Form (relevé 294). All the relevés were situated on shallow slopes (9°–14°), between rock outcrops, where rock cover was very low except in relevé 294 where it was estimated at 20%.

The differential species of the *Protea neriifolia*–*Erica articularis* Shrublands are not constant throughout the community, nor do they have high cover-abundance. Of these species, *Erica articularis* and *Ischyrolepis sieberi* have highest cover-abundance whereas the remaining species are rare (Table 2). The very rare legume, *Coelidium cynbifolium*, previously known from only two collections, Muir's type collection and a collection of Middlemost (Granby 1980), was found in relevés 293 and 294 and appears to be narrowly endemic to this community. *Protea aspera*, a prostrate rhizomatous shrublet, was also recorded in this community and the *Leucadendron eucalyptifolium*–*Elegia filacea* Shrublands (see below and Table 2). This species is best known from Onrust to Bredasdorp but has also been recorded from an isolated population in the Langkloof, east of Garcia's Pass (Rourke 1980). Records of *Protea aspera* at Phesantefontein represent an extension of the range of the Langkloof population 5 km west of Garcia's Pass.

The *Protea neriifolia*–*Erica articularis* Shrublands are dominated by restios such as *Ceratocaryum decipiens*, *Elegia galpinii*, *Mastersiella purpurea*, *Restio filiformis*, *Thamnochortus ellipticus* and *Staberoha cernua*, all species preferring mesic to dry habitats. *T. ellipticus* was originally collected by Muir in the Phesantefontein area and is only known from this, the type locality (Linder 1985).

3.1.2 *Leucadendron eucalyptifolium*–*Elegia filacea* Shrublands

Differential species: *Calopsis filiformis*, *Elegia filacea*, *Hypodiscus laevigatus*.

Dominant species: *Elegia filacea*, *Protea repens*.

Structural formation: Low Closed Graminoid (Restioid/Cyperoid) Shrubland with Tall Open Proteoid Overstorey.

Relationships: as for 3.1.1.2 above and *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands (McDonald 1993a).

Two relevés, 295 and 296, represent this community (Figure 18). It is found below the *Leucadendron eucalyptifolium*–*Erica articularis* Shrublands, and is floristically transitional between them and the *C. aculeata*–*Protea lorifolia* Shrublands. Both relevés were at 530 m on slopes with a shallow gradient. The soil which is 0.25–0.3 m deep is a light grey sandy loam with quartz pebbles and gravel on the surface. Rock cover is nil and the soils are classified as Glenrosa Form.

Elegia filacea is most often found on accumulated sand and the sandy nature of the soil accounts for its presence here. In this community it dominates the understorey in



FIGURE 17.—The *Protea neriifolia*–*Erica articularis* Shrublands on the lower north-facing slopes above Phesantefontein.

which grasses are absent and sedges few, mainly of the genus *Ficinia*. Low shrubs play a subordinate role in the understorey composition, but the presence of *Protea aspera*, which also favours sandy soil, should be noted. The upper (tall) stratum is composed of proteoid shrubs with *Protea repens* dominant.

The rare, endemic *Erica rhodantha* Guth. & Bol. was found in this community. This species is apparently restricted to the fynbos shrublands of the lower north slopes of the Langeberg in the region of Garcia's Pass. Few collections of this species have been made (E.G.H. Oliver pers. comm.).

The *Leucadendron eucalyptifolium*–*Elegia filacea* Shrublands are the same as the *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands described from BWA (McDonald 1993a), but for the purposes of this paper are treated as slightly different. The difference is based on the presence of *Calopsis filiformis*, *Hypodiscus laevigatus*, *Protea aspera* and *Thamnochortus ellipticus* at Phesantefontein and not at BWA.

3.2 *Cullumia aculeata*–*Protea lorifolia* Shrublands

This community, found at the driest extreme of the south-north climatic gradient of the Langeberg, is divided into two: the *Protea lorifolia*–*Ficinia laciniata* Shrublands (which fall within the *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands of the BWA) and the *Protea lorifolia*–*Leucospermum calligerum* Shrublands (which are equivalent to the *Passerina obtusifolia*–*Leucospermum calligerum* Shrublands at BWA). The *Cannoniois parviflora*–*Passerina obtusifolia* Shrublands found at BWA (McDonald 1993a) were not identified as a separate community at Phesantefontein but as part of the *Passerina obtusifolia*–*Leucospermum calligerum* Shrublands.



FIGURE 18.—The *Leucadendron eucalyptifolium*–*Elegia filacea* Shrublands.

3.2.1 *Protea lorifolia*–*Ficinia laciniata* Shrublands

Differential species: *Cammois parviflora*, *Dodonaea angustifolia*, *Ficinia laciniata*, *Gnidia francisci*, *Linum gracile*, *Othouma* sp., *Polygala refracta*, *Siphocodon* cf. *spartioides*, *Syncarpha milleflora*, *Thesium subnudum*.

Dominant species: *Leucadendron salignum*, *Pentastichis colorata*, *Hypodiscus aristatus*, *Tetraria ustulata*.

Structural formation: Low Mid-dense Sedgeland or Graminoid Shrubland with Mid-high Sparse Proteoid Shrubs in some stands.

Relationships: Proteoid Zone Fynbos (Taylor 1978); Broad-sclerophyllous Scrub or Open Scrub (Kruger 1979); *Elegia galpinii*–*Metalasia pulcherrima* Community (Outeniqua Mountains) and *Protea repens*–*Protea lorifolia*–*Hypodiscus striatus* Community (Swartberg) (Bond 1981); Mesic Mountain Fynbos (Moll *et al.* 1984); Thomas Dry Proteoid Fynbos (Campbell 1985); *Leucadendron eucalyptifolium*–*Protea lorifolia* Shrublands (McDonald 1993a).

This community was not found or sampled at Phesantefontein. The four relevés (278–281) representing the *Protea lorifolia*–*Ficinia laciniata* Shrublands were situated on the moderately steep, rocky, north-facing slopes of Witelsberg on the Bergfontein transect at altitudes from 545–730 m. The soils are shallow (0.1–0.15 m) sandy Mispah Form lithosols and surface exposure of rock was estimated to be 91% on average.

This community is well differentiated from the other shrublands represented in Table 2. This could be ascribed either to geographical separation of these relevés from the Phesantefontein area or to the habitat where this shrubland occurs not being present or not sampled at Phesantefontein. Topographically, in rockiness and in climatic regime, the north-facing slopes of Witelsberg closely resemble the north-facing slopes of Deception Ridge in BWA (McDonald 1993a). At Phesantefontein, however, moderately

steep, rocky, well-drained slopes of the same type are absent. The 'habitat explanation' for the absence of this community at Phesantefontein therefore seems the most plausible.

Leucadendron salignum, *Hypodiscus aristatus*, *Pentastichis colorata* and *Tetraria ustulata* dominate the community at this early stage of its development (6 years old), forming a low, mid-dense graminoid shrubland. As these shrublands mature it is predicted that the proteoid shrubs, *Protea lorifolia* and *Protea repens* will form a mid-high to tall, open to mid-dense overstorey.

3.2.2 *Protea lorifolia*–*Leucospermum calligerum* Shrublands

Differential species: *Adromischus triflorus*, *Anthospermum spathulatum*, *Calopsis rigida*, *C. marlothii*, *Cliffortia pulchella*, *Clusia laxa*, *Cymbopogon marginatus*, *Hermannia odorata*, *Heterolepis* sp. nov., *Lightfootia rigida*, *Machairophyllum cookii*, *Metalasia massonii*, *Montinia caryophyllacea*, *Passerina obtusifolia*, *Pentastichis marouinensis*, *Phyllica purpurea*, *Thamnochortus karoocica*.

Dominant species: *Elegia galpinii*, *Leucospermum calligerum*, *Thoracosperma galpinii*, *Willdenowia bolusii*.

Structural formation: Low to Mid-high Mid-dense Graminoid Shrubland with Sparse emergent Proteoid Shrubs in some stands.

Relationships: Arid Fynbos (Taylor 1978; Kruger 1979); *Phyllica axillaris*–*Felicia filifolia* Community (Outeniqua Mountains) and *Passerina obtusifolia*–*Felicia filifolia*–*Pentastichis eriostoma* Community (Swartberg) (Bond 1981); Dry Mountain Fynbos (Moll *et al.* 1984); Sebrafontein Dry Asteraceous Fynbos (Campbell 1985); Dry Proteoid Fynbos (Rebello *et al.* 1991); *Passerina obtusifolia*–*Leucospermum calligerum* Shrublands (McDonald 1993a); *Leucadendron eucalyptifolium*–*Hypodiscus argenteus* Shrublands in part (McDonald 1993b).

This community (Figure 19) is found on the low, arid northern foothills of Phesantefontein at altitudes from 450–520 m. The slope varies from almost level (5°) to 14° and the soils are mostly shallow (<0.1 m), well-drained, rocky (75–98%) Mispah Form soils. The exception is the Glenrosa Form soil of relevé 285 which is 0.25 m deep with an estimated surface rock cover of only 3%! Relevé 283 was situated on a rocky outcrop and was the only site where *Passerina obtusifolia* was recorded. The silcrete-capped mesas at Phesantefontein present a similar substratum and habitat to that found in relevé 283 and therefore, although these mesas were not sampled, it is predicted that they will support shrublands of the *Protea lorifolia*–*Leucospermum calligerum* type (Phesantefontein) or the *Cammoois parviflora*–*Passerina obtusifolia* type (Witbooisrivier; McDonald 1993a).

These shrublands are well defined with numerous differential species. *Heterolepis* sp. nov. (as yet undescribed), the succulent *Machairophyllum cookii* (Mesembryanthemaceae) and *Thamnochortus karoocica* are endemic to this community. Species with single occurrences have been retained in Table 2 specifically for this community, for the sake of completeness. They are, however, not truly differential.

Leucospermum saxatile which is endemic to the Arid Fynbos east of Garcia's Pass (Rourke 1972) was noted in this community on the northern footslopes of Witelsberg prior to the May 1991 fire. *Serruria balanocephala* Rourke ined. found in this community at Witbooisrivier (McDonald 1993a) has not been found at Phesantefontein nor further east. *Leucospermum erubescens* recorded from Springfontein immediately west and at Garcia's Pass directly east of Phesantefontein was also not encountered at the latter locality and is apparently also not found much further east than Garcia's Pass.

Owing to the extensive fires on the Langeberg east of Garcia's Pass in the recent past, much of the vegetation on the lower northern slopes of the range is immature and thus not suitable for sampling. However, it can be confidently stated that the community named the *Passerina obtusifolia*-*Leucospermum calligerum* Shrublands (McDonald 1993a) and the *Protea lorifolia*-*Leucospermum calligerum* Shrublands (this paper) extend along the base of the Langeberg from Barrydale to the Gouritz River, fringing the Little Karoo.

DISCUSSION AND CONCLUSIONS

The hierarchical classification and description of the fynbos communities of the Bergfontein and Rooiwaterspruit-Phesantefontein areas satisfies the primary objective of the study. It also provides a framework which, together with differential species for each community, is a starting point for describing the communities over a wider area on the southeastern Langeberg. Further sampling in other areas would serve to test this classification and would most likely identify additional communities.

From the perspective of management of the fynbos of the Langeberg mountain catchments, this classification is perhaps too detailed and, as may be argued, too floristically orientated. However, it is important to be able to

classify plant communities at all stages of the succession. This has raised much debate (Cowling & Holmes 1992) and it has been generally concluded that when applying structural classifications it is only possible to satisfactorily classify mature fynbos plant communities (Campbell 1985). Finding stands of mature fynbos (>10 years old) is becoming increasingly difficult (Campbell 1985; this study) so applying structural classifications becomes equally difficult. Despite the complexity of the vegetation in this study, the successful hierarchical classification of the mainly immature fynbos, and the determination of character species for communities highlights a major advantage in using the floristic classification approach. If suitably interpreted, by using the character species for different communities, the complex taxonomy of the fynbos need not be the reputed daunting obstacle for managers of fynbos vegetation (Bond 1981).

In general, the communities described for the Bergfontein and Rooiwaterspruit-Phesantefontein areas are similar to those described by McDonald (1993a & b) for the Boosmansbos Wilderness Area and the Marloth Nature Reserve. Degree of difference or conversely, similarity of the fynbos communities of the southern Langeberg, which is beyond the scope of this paper, can now be assessed. A proposed synthesis is now possible which is aimed at being generally applicable in the Langeberg fynbos shrublands, and hopefully beneficial to the conservation and management of these shrublands.

Apart from the purely descriptive reference to environmental conditions pertaining to each community, little indication is given of environmental variables as the causal agents of species distribution and species composition of communities. This forms a separate aspect to the study of the Langeberg vegetation and will be reported separately (McDonald unpublished data).

The *Erica versicolor*-*Agathosma ovata* Shrubland found on Koksposberg does not fit well within the hierarchy of communities. This was evident in both the phytosociological tables and the ordination of the data. Many of the fynbos species found generally on the south slopes of the Bergfontein area are found in this community but the succulent differential species indicate an azonal xeric community. A clear definition of this community and its relationships to other fynbos vegetation will only be possible given additional samples. It is predicted to occur on the sandstone outliers of the Langeberg east of Garcia's Pass as described and possibly on the Aasvogelberg near Albertinia.

Garcia's Pass has historically given ready access to the Muiskraal area at its northern entrance. It has thus been an area much visited by botanists since the time of Thunberg and Masson in the late 1700's. Many collections of Langeberg north slope endemic species have Muiskraal as the type locality, notably many of Muir's collections. Many of these species are considered rare. Some of these species such as *Coelidium cymbifolium* and *Erica rhodantha* have been found in this survey at Phesantefontein which lies just west of Muiskraal. The intensity of sampling in this study has, however, been too limited to cover the area adequately. It is proposed therefore that the areas on the north slopes of the Langeberg west and east of



FIGURE 19.—The *Protea lorifolia*-*Leucospermum calligerum* Shrublands found on the flow, arid foothills of the Phesantefontein area.

Garcia's Pass require thorough botanical investigation. If these areas have high numbers of endemic plant species as is indicated by this survey, these north slopes of the Langeberg deserve a higher conservation status than is currently the case.

ACKNOWLEDGEMENTS

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Errata in Bothalia 23,1: 157

The vegetation of the southern Langeberg, Cape Province. 2. The plant communities of the Marloth Nature Reserve, by D.J. McDonald.

Replace 3rd paragraph, left column with:

The climate of the MNR is typical of the southern Langeberg since it falls within the transition zone between winter and year-round rainfall areas. The mean annual rainfall for the peaks is estimated to be >1 400 mm (Dent *et al.* 1987). However, the climate on the south side of the range is distinctly different from that on the north side. The south slopes of the southern Langeberg experience the highest rainfall in late summer to autumn (March & April) and late winter to spring (August, October & November). The driest periods are early summer (December) and early winter

(June), Figure 5A. A more marked bimodality is evident in the rainfall pattern on the north slopes which are in a summer rainshadow. Here peaks in rainfall occur in autumn (April & May) and late winter (August). The driest period extends from spring to late summer (October–March), Figure 5B. The mean summer maximum and mean winter minimum temperatures for Swellendam are 29.4°C (January) and 6.6°C (July) respectively. On the opposite side of the mountain at Weltevrede the equivalent temperatures are 30.0°C (February) and 2.9°C (July).

The efficient use of small plots in a fynbos phytosociological study in the northern Cederberg: a quick way to collect plant-environmental data

P.J. MUSTART*, E.J. MOLL* and H.C. TAYLOR**

Keywords: Cederberg, phytosociological survey, small plot sizes

ABSTRACT

A phytosociological survey of selected plant communities in the northern Cederberg was made using small (4–16 m²) plot sizes. A satisfactory phytosociological table was obtained, and plant-environmental relationships were inferred from it. The use of small plot sizes enabled ecological information about plant communities to be quickly, easily and efficiently obtained. This method could be of considerable use for establishing and monitoring vegetation patterns.

UITTREKSEL

'n Fitososiologiese opname van geselekteerde plantgemeenskappe in die noordelike Cederberg is gemaak, en klein (4–16 m²) perseelgroottes is gebruik. 'n Bevestigende fitososiologiese tabel is verkry, en plant-omgewingsverhoudings is daaruit afgelei. Die gebruik van klein perseelgroottes het daartoe gelei dat ekologiese inligting oor plantgemeenskappe vinnig, maklik en doeltreffend verkry kon word. Hierdie metode sou heel nuttig vir die bepaling en monitering van plantegroecipatrone gebruik kon word.

INTRODUCTION

The Zürich-Montpellier, or Braun-Blanquet, approach has been widely used to survey and classify vegetation (Werger 1974). The aim of such studies is to describe the communities of the chosen area and to correlate them with environmental factors. In South Africa these vegetation studies have been carried out at scales ranging from regional, comprising several thousands of hectares (Boucher 1978; Cowling 1984; Taylor 1984), to smaller areas of a few hundred hectares and less (Werger *et al.* 1972; Cowling *et al.* 1976; Campbell & Moll 1977; McKenzie *et al.* 1977; Glyphis *et al.* 1978; Laidler *et al.* 1978; Campbell *et al.* 1980; Van Wilgen & Kruger 1985). In these studies plot size has ranged from 4 to 200 m²; choice of plot size has largely depended on floristic richness and structure of the communities sampled, and usually ignores the small-scale pattern. Relatively small plots (e.g. 25 m²) have been suggested as suitable for reflecting less habitat heterogeneity than larger plot sizes, in turn leading to the unmasking of subtle variations within the observed communities (Van Wilgen & Kruger 1985).

Large plots possibly covering heterogeneous habitats and hence reflecting transitional communities, are time-consuming for data collection. Small plots obviate both these problems. The aim of this study was to perform a phytosociological survey in the northern Cederberg using plots of small size (4–16 m²) in order to see if a satisfactory Braun-Blanquet table could be obtained, and if plant-environmental patterns could be inferred.

STUDY AREA

The area surveyed was in the Pakhuis Pass area of the northern Cederberg at altitudes ranging from 600 to 1 000 m. The communities sampled lay between 18° 59' E to 19° 04' E, and 32° 08' S to 32° 11' S, covering an area of approximately 300 hectares. The vegetation is described as Mesic Mountain Fynbos (Moll *et al.* 1984). The geology of the area is quartzitic sandstone of the Peninsula Formation of the Table Mountain Group. The area falls within the 60% winter rainfall region. The annual rainfall is 480 mm of which 72% falls between April and August (winter). Mean monthly maximum temperatures range from 20°C (winter) to 30°C (summer). Mean minimum temperatures drop to 5°C in midwinter.

METHODS

The area was surveyed using aerial photographs in order to broadly identify communities. Braun-Blanquet techniques as described by Werger (1974) were used. Since plant relationships with the environment, and with other plants, will be related to both the scale of environmental variation and to plant size, relevé size was chosen in relation to vegetation structure (height) as follows: 2 × 2 m (<1 m in height); 2 × 4 m (1–2 m in height); and 4 × 4 m (>2 m in height). The following data were collected in January 1986: floristic lists and cover abundance for each of five to six relevés per community (22 plots in total); species not in the relevé, but occurring in the surrounding area in a 1–2 m border round the plot recorded as (+). Environmental data, as set out in Table 1, were recorded for each relevé. The computer program TWINSpan (two-way indicator species analysis, Hill 1979) was applied to the raw data, producing a tabular matrix approximating Braun-Blanquet table work. The matrix was further sorted by hand.

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TABLE 1.—Phytosociological table of northern Cederberg communities

Height of tallest stratum (m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6	6	3	4	4
Plot size (m²)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	16	16	16	16	16
Rock cover (superscripts are BB cover values)	n	n	n	n	n	n	b ¹ ₁₂	II ³	III ³	III ²	II ³	b ¹ ₁₂	b ²	b ³	b ²	I ⁴ _{II²}	b ¹	III ²	II ¹	n	II ¹	b ²	
Aspect	-	-	NW	NW	-	-	E	NE	NW	E	E	E	-	-	N	NE	-	SE	SE	S	SW	NW	
Soil depth	3	2	3	3	3	2	0I	0I	1	0	0I	0I	0I	0I	1	1	0I	2	2	2	2	2	
Soil moisture	d	d	d	d	d	d	d	d	d	d	d	d	df	df	df	df	df	dr	dr	dr	dr	dr	
Slope	0	0	0	1	0	0	1	3	2	3	3	1	0	0	0	0	0	0	0	0	1	1	
Altitude (m)	970	1000	900	900	900	1000	910	980	900	1050	910	910	890	880	880	830	830	900	900	600	920	920	
Number of species	22	18	16	15	14	8	6	18	15	13	18	13	9	8	10	14	8	22	14	17	11	12	
Relevé	1	5	4	2	3	6	17	13	14	12	15	16	10	11	7	8	9	18	19	22	20	21	

Community 1

<i>Thamnochortus platypterus</i>	3	2	1	3	2	2
<i>Willdenavia areolens</i>	1	1	1	1	2	(+)
<i>Ischyrolepis mananthos</i>	2	2	3	2	2	
<i>Macrostylis decipiens</i>	2	(+)	2		(+)	
<i>Metalasia agathosmoides</i>	2	1	1	(+)		
<i>Aristea</i> sp.	+	+	1	1		
<i>Thesium</i> sp. (H.T.10759)	2	1	(+)			
<i>Rafnia diffusa</i>	2	+	+			
<i>Ficinia dunensis</i>	1	1	(+)			
<i>Ischyrolepis</i> sp. (cf. <i>curviamis</i>)		1		2		
<i>Pentastichis viscidula</i>			1	1		
<i>Muralia</i> sp. (H.T.11380)	1		1			
<i>Ficinia bulbosa</i>	1	1				
<i>Grisebachia ciliaris</i>	2	+				
<i>Phaenocoma</i> sp.			1	(+)		
Campanulaceae (H.T.10861)	1	+				
<i>Helichrysum</i> sp.				+	+	
Thymelaeaceae			(+)		1	
<i>Tetraria nigravaginata</i>	(+)				(+)	
<i>Mesembryanthemum</i> sp.		+	+			
<i>Pelargium</i> sp.	+	+				
<i>Thesium nudicaule</i>	(+)	(+)				
<i>Ursinia</i> sp.	1		(+)			
<i>Elytropappus</i> sp. (H.T.909/4)	+					

Subcommunity 2b

<i>Cannamois parviflora</i>				2		
<i>Anthospermum aethiopicum</i>						
<i>Tetraria ustulata</i>						
<i>Ficinia deusta</i>	1			(+)		
<i>Metalasia densa</i>			1			
<i>Cymbapagan marginatus</i>			2			
<i>Chasmanthe</i> sp.						
<i>Tetraria cuspidata</i>				4		
<i>Clusia alaternoides</i>					1	
<i>Elytropappus</i> sp.					+	
<i>Hypodiscus neesii</i>					1	3
<i>Pentastichis curvifolia</i>					1	1
<i>Struthiola ciliata</i>				+	+	
<i>Selago</i> sp.					+	+
Campanulaceae					+	+

Subcommunity 2a

<i>Ischyrolepis gaudichaudiana</i>			2	3		1	3
<i>Mexmuellera arundinacea</i>			(+)	1			

Community 2

<i>Ischyrolepis sieberi</i>		2	2	3	3		1	1	3
<i>Stoebe plumosa</i>				3	1	2		2	2
<i>Ficinia nigrescens</i>				1	(+)	+	(+)	+	+
<i>Chiffartia ruscifolia</i>						+	1	3	1
<i>Lobastemon glaucophyllus</i>				(+)			(+)	(+)	(+)

Subcommunity 3b

<i>Indigofera frutescens</i>									
<i>Pentastichis</i> sp.									
<i>Lidbeckia quinqueloba</i>									
<i>Rhus rimosa</i>									

BB cover values: (+) = not in quadrat, but occurring in surrounding area in a 1 to 2 m border round plot; + = <1% of quadrat area; 1 = 1–5%; 2 = 5–25%; 3 = 25–50%; 4 = 50–75%; 5 = 75–100%.

Rock cover (superscripts are BB cover values): n = none; b = bedrock; III = rock size (ht), >0.5 m; II = 0.25–0.5 m; I = 0.05–0.25 m.

Soil depth: 0 = skeletal, <0.05 m; I = shallow, 0.05–0.15 m; 0I = mixed skeletal and shallow; 2 = medium, 0.15–1.00 m; 3 = deep, >1.0 m.

Soil moisture: d = dry, well drained; df = dry, flat, hard surface; dr = dry, well drained with runoff.

Slope: 0 = level, 0–3°; 1 = gentle, 4–8°; 2 = moderate, 9–16°; 3 = steep, 17–26°.

TABLE 1.—Phytosociological table of northern Cedarberg communities (continued)

Height of tallest stratum (m)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6	6	3	4	4
Plot size (m ²)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	16	16	16	16	16
Rock cover (superscripts are BB cover values)	n	n	n	n	n	n	b ¹ ₁₂	III ³	III ³ _{III³}	II ² _{III²}	III ³	b ¹ ₁₂	b ²	b ³	b ²	I ⁴ _{II²}	b ¹	III ²	III ¹	n	III ¹	b ²
Aspect	-	-	NW	NW	-	-	E	NE	NW	E	E	E	-	-	N	NE	-	SE	SE	S	SW	NW
Soil depth	3	2	3	3	3	2	0I	0I	1	0	0I	0I	0I	0I	1	1	0I	2	2	2	2	2
Soil moisture	d	d	d	d	d	d	d	d	d	d	d	d	df	df	df	df	df	dr	dr	dr	dr	dr
Slope	0	0	0	1	0	0	1	3	2	3	3	1	0	0	0	0	0	0	0	0	1	1
Altitude (m)	970	1000	900	900	1000	910	980	900	1050	910	890	880	880	830	830	900	900	600	920	920		
Number of species	22	18	16	15	14	8	6	18	15	13	18	13	9	8	10	14	8	22	14	17	11	12
Relevé	1	5	4	2	3	6	17	13	14	12	15	16	10	11	7	8	9	18	19	22	20	21

Subcommunity 3a

Myrsine africana
Chirania baccifera
Diaspyras glabra
Phytica aleifolia
Euclea acutifolia
Viscum sp.
Rhus undulata

	1	+	2		
	+	+	+		+
	+	(+)		+	
+	(+)		2		
	+		(+)		
	(+)		+		
	+	1			

Community 3

Olea europaea subsp. *africana*
Maytenus aleaides
Heeria argentea
Euclea natalensis
Ficinia acuminata
Pratasparagus scandens
Pratea nitida

5	2	3		2
1	(+)	(+)	2	(+)
4	2		3	2
		1	(+)	(+)
1				+
			+	+
(+)			(+)	

Widespread species

Eriocephalus africanus
Ehrharta ramosa

+		(+)													2				(+)				
			2		+		+	+		1	1	2			1	+	+			+	+	+	+

BB cover values: (+) = not in quadrat, but occurring in surrounding area in a 1 to 2 m border round plot; + = <1% of quadrat area; 1 = 1–5%; 2 = 5–25%; 3 = 25–50%; 4 = 50–75%; 5 = 75–100%.

Rock cover (superscripts are BB cover values): n = none; b = bedrock; III = rock size (ht), >0.5 m; II = 0.25–0.5 m; I = 0.05–0.25 m.

Soil depth: 0 = skeletal, <0.05 m; 1 = shallow, 0.05–0.15 m; 0I = mixed skeletal and shallow; 2 = medium, 0.15–1.00 m; 3 = deep, >1.0 m.

Soil moisture: d = dry, well drained; df = dry, flat, hard surface; dr = dry, well drained with runoff.

Slope: 0 = level, 0–3°; 1 = gentle, 4–8°; 2 = moderate, 9–16°; 3 = steep, 17–26°.

Species not included in the above and found in one relevé only (species name is followed by relevé number, cover abundance value): *Agathasma* sp. 13, +; *A. pubigera/esterhuyseniae* 6, 1; *Arctatis laevis* 1, (+); *A.* sp. 2, 2; *Aspalathus spinosissima* 8, 1; *A. tridentata/quinguefolia* 2, (+); *Aristea singularis* 20, +; *Babiana* sp. 8, 1; *Cassine peragua* 19, (+); *Chrysocoma tenuifolia* 22, (+); *Crassula atropurpurea* 9, +; *Cullumia bisulca* 8, 2; *Dilataris ixiaides* 17, (+); *Diasma acmaeophylla* 9, (+); *Diaspyras austro-africana* 19, 1; *Dadaneaa viscasa* 22, +; *Erica* cf. *articularis* 7, +; *Eriacephalus* sp. 5, 1; *Euclea linearis* 22, 1; *E. undulata* 22, +; *Ficinia cedarbergensis* 15, (+); *F. campar* 5, 1; *Gnidia* sp. 3, 1; *Helichrysus rutilans* 3, +; *Hypadiscus argenteus* 15, 1; *Kiggelaria africana* 19, (+); *Klawlatania capensis* 22, +; *Leucadendran canavum* 1, +; *Lobelia* sp. 14, +; *Macrostylis squarrosa* 7, 2; *Manulea* sp. 3, (+); *Maytenus heterophylla* 22, 1; *Muraltia* sp. 16, +; *Othanna amplexifolia* 22, (+); *Passerina glomerata* 8, 1; *Pelarganium* cf. *crithmaides* 8, +; *P. scabrum* 12, 1; *Pharnaceum* sp. 2, +; *Podacarpus elangatus* 19, 2; *Prismaacarpus* sp. 1, +; *Pratasparagus* sp. 18, +; *Pratea acaulas* 2, (+); *Restia* sp. (H.T. 00714) 6, 3; *Rhus dissecta* 22, (+); *R. scytophylla* 19, +; *R. tamentosa* 18, 1; *Scabiosa* sp. 3, 1; *Secamane alpinii* 18, (+); *Selaga* sp. 13, +; *Serruria aitanii* 2, (+); *Staebe* sp. 4, +.

RESULTS AND DISCUSSION

There are three major floristic communities (Table 1).

1. *Thamnochortus platypteris*–*Willdenowia arescens* Community

This community is an open herbland occurring in relevés 1 to 6, and differential species are *Thamnochortus platypteris* and *Willdenowia arescens*. This graminoid guild is further represented by high cover of *Ischyrolepis monanthos* in all relevés except number 6 (which in general has few species); as well as *Ficinia dunensis* in three

relevés; and *Ischyrolepis* cf. *curviramis*, *Pentaschistis viscidula*, *Tetraria nigrovaginata* and *Ficinia bulbosa* in two relevés each. *Macrostylis decipiens* and *Rafnia diffusa* are low sprawling bushes (± 300 mm high), together forming an understorey to the restioid stratum in three relevés. *Metalasia agathosmoides* occurs in four relevés, and there is an occasional low presence of further asteraceous species, *Phaenocoma* sp., *Helichrysus* sp., *Elytropappus* sp. and *Ursinia* sp., in some of the relevés.

This community occurs on flat, sandy plains that are fully exposed to sun and wind. The soil is well drained

and deep (>1 m in four relevés, and 0.15–1.00 m in two relevés), and consists of a coarse-textured pale grey sand. There is no rock cover. These factors, together with the hot, dry summers and low annual rainfall create generally very dry conditions.

The widespread and generally high cover of Restionaceae species substantiates the hypothesis that these shallow-rooted species are suited to survive in areas exposed to severe summer drought due to their ability to respond to summer moisture flushes with very rapid photosynthesis (Van der Heyden & Lewis 1989). The presence of both graminoids and Asteraceae concurs with Campbell's (1986) finding that these taxa predominate at the dry end of fynbos gradients. The occasional presence of deeper-rooted proteoids (*Leucadendron concavum*, *Protea acaulos* and *Serruria aitonii*), each occurring in only one relevé, indicates the infrequent availability of sufficient water at deeper levels.

2. *Ischyrolepis sieberi*–*Ficinia nigrescens* Community

This mid-dense graminoid shrubland has *Ischyrolepis sieberi* and *Ficinia nigrescens* as differential species. There is also a high cover of the shrubs *Stoebe plumosa* and *Cliffortia ruscifolia*, in many of the relevés. This community is spread over two different landscape forms: relevés 7 to 11 occur on level areas with much exposed bedrock, and relevés 12 to 17 occur on well-drained rocky slopes (gentle to steep). Both environments have soils varying in depth from skeletal to shallow, and consisting of dark brown, mixed fine and coarse sand particles. Soil of the bedrock environment type was dry and well drained when examined in mid-summer, but during winter rains the underlying bedrock could cause water accumulation. Soils on the rocky slopes would be well drained during the rainy season.

Subcommunity 2a

This subcommunity of five relevés (7–11) on level bedrock has *Ischyrolepis gaudichaudiana* as sole differential species. *Merxmüllera arundinacea* occurs in two relevés.

Subcommunity 2b

This subcommunity occurs in the six relevés (12–17) of the rocky slopes environment, and has *Camomois parviflora* and *Anthospermum aethiopicum* as differential species. Other graminoid species such as *Tetraria ustulata*, *T. cuspidata* and *Ficinia densta* commonly occur as do the shrubby components *Metalasia muricata* and *Struthiola ciliata*. Within sight of each relevé was a mature *Protea nitida* and/or *P. laurifolia* forming a sparse woodland overstorey. The aspect of these slopes is mostly east with the one northwest-facing relevé (No. 14) being near to a seepage area. This, together with the high rock cover, would make it a less dry and less wind-exposed environment than the bedrock one, and could account for the absence of most of this subcommunity's species in the level bedrock environment (relevés 7–11). Furthermore, the rockiness in combination with slope-related drainage patterns would result in a variety of moisture-related microhabitats. This could also be the cause of the greater numbers of species found on the rocky slopes than on the

level bedrock. Greater species richness on rocky slopes than on level areas in arid areas has been attributed to these factors (Barbour & Diaz 1973; Olsvig-Whittaker *et al.* 1983).

3. *Olea europaea* subsp. *africana*–*Maytenus oleoides* Community

The differential species of this closed woodland are *Olea europaea* subsp. *africana* and *Maytenus oleoides*. These, as well as *Heeria argentea* and *Euclea natalensis*, are common to most of the relevés of subcommunities 3a and 3b. This community occurs adjacent to large boulders (4 m and higher) which provide shelter from wind, sun and fire, as well as extra moisture due to shade and water runoff. Soils are of medium depth and the slope level to gentle. This has allowed the development of a closed woodland of trees and shrubs. *Cassine peragua*, a forest tree (in one relevé, No. 19), and *Protasparagus scandens*, common in forest undergrowth, indicate the tendency of succession to low forest. Substantial forest development in this community is undoubtedly limited by the low rainfall of the area, and the fact that the prevalence of fire on the adjacent plains severely limits the forest area.

Subcommunity 3a

The differential species are *Myrsine africana* and *Chironia baccifera* in this subcommunity which occurs in three relevés. These, together with *Diospyros glabra* and *Euclea acutifolia* form an understorey to the closed woodland canopy. The ground layer is poorly developed and consists of sparsely occurring *Chironia baccifera*. These species are mostly excluded from the drier subcommunity 3b.

Subcommunity 3b

Indigofera frutescens and *Pentastichis* sp. are differential species. This subcommunity represents a drier gradient of Community 3 since the relevés in which it occurs (20 and 21) have more sunny aspects (SW and NW) than the other relevés which face S or SE. This could account for the absence of most of these species in the former subcommunity, and *vice versa*. These two subcommunities appear to reflect moisture-related microhabitat differences within the woodland community.

CONCLUSIONS

A satisfactory phytosociological table was produced using small plot sizes. We obtained a neat phytosociological table, with well-defined communities. This in itself indicates the existence of small-scale pattern in fynbos. The survey was quickly (five days field work) and easily achieved. The efficiency of this method would allow comparatively easy monitoring and quick establishment of plant-environmental relationships.

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The vegetation ecology of municipal Durban, Natal. Floristic classification

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Keywords: floristic classification, municipal Durban, phytosociology, PHYTOTAB, urban open space

ABSTRACT

The vegetation of municipal Durban is classified according to the Braun-Blanquet method, using the PHYTOTAB program package. Five major vegetation types with 18 communities are described, as are the major environmental factors influencing vegetation composition and structure.

UITTREKSEL

Die plantegroei van Durban se munisipale gebied is volgens die Braun-Blanquet-metode met behulp van die PHYTOTAB-programpakket geklassifiseer. Vyf hoof plantegroeitypes met 18 gemeenskappe word beskryf, asook die bepalende omgewingsfaktore wat plantegroeisamestelling en -struktuur beïnvloed.

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INTRODUCTION

In order to facilitate ecologically effective open space planning and management within municipal Durban, a comprehensive survey of all the remaining vegetated areas within the city was undertaken. This excluded landscaped or formally managed areas (e.g. parks, gardens and agricultural lands). The study included classification of the vegetation in terms of both floristics and structure, as well as correlation of the vegetation classification with a range of environmental parameters. This latter facilitated a more accurate interpretation of the current ecological status and conservation value of the City's urban open space resources.

STUDY AREA

The study area incorporates two local authority areas: namely municipal Durban and Yellowwood Park. Although Yellowwood Park is administered by an independent health committee, it is completely encircled by municipal Durban, and is included within the boundaries of the study area to ensure physical continuity (Figure 1). At the commencement of the study in 1983, municipal Durban and Yellowwood Park together covered an area of approximately 300.13 km² (P. Johnson pers. comm.); 8.5 km² of which was covered by open water in Durban

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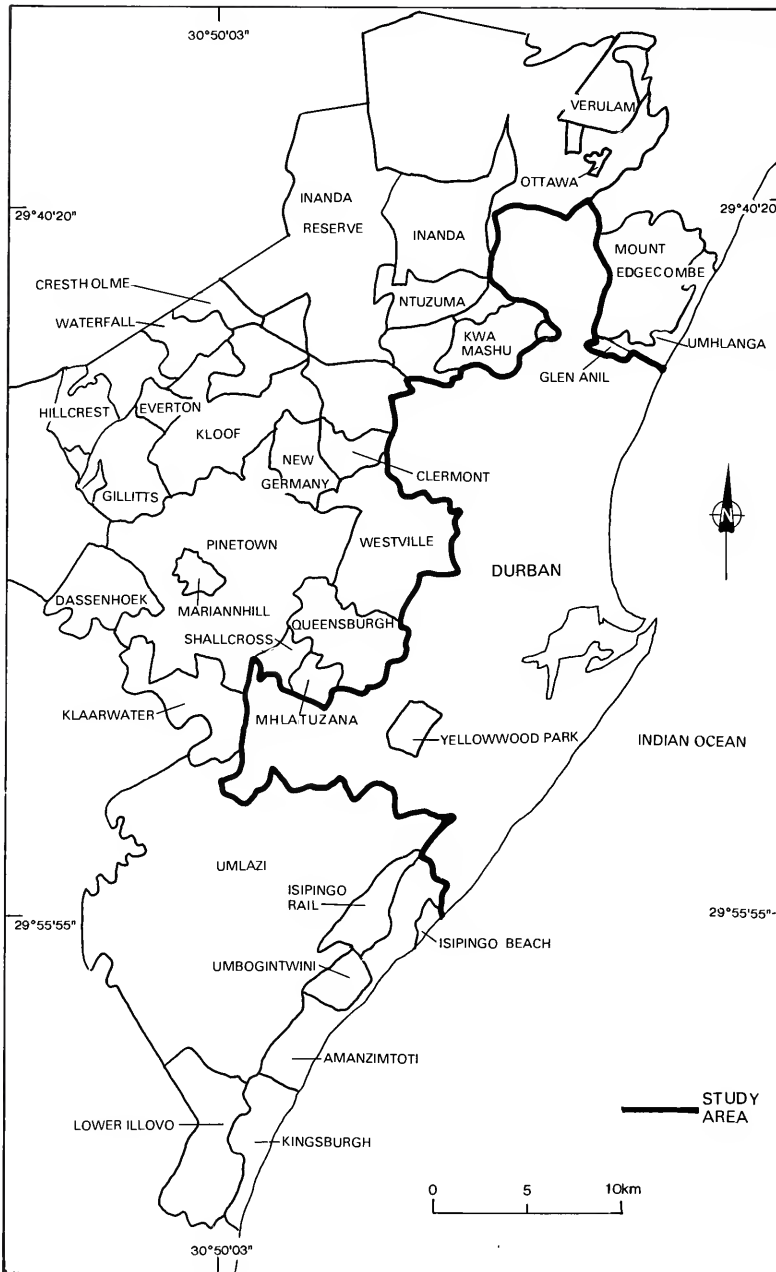


FIGURE 1.—Location of the study area.

Harbour. In 1985/1986, the Durban municipal boundaries were altered as a result of extensions made in the Isipingo and Phoenix areas. Because of the difficulty of altering the boundaries of the study area midway through the research, and the fact that these changes would not significantly affect or compromise the outcome of the study, the original municipal boundaries were retained.

Accordingly, the Umlaas River marks the southern limit of the study area as far as the Umlaas canal, from whence the boundary follows the route of the previously uncanalised river to the coast at Isipingo. To the west and north the study area is flanked by the districts of Klaarwater, Pinetown, Shallcross, Umhlatusana, Queensburgh,

Westville, Chesterville, Clermont, KwaDabeka, Kwa-Mashu, Duff's Road, Inanda, Mount Edgecombe, Glen Anil and Umhlanga. This area is bounded by latitudes $29^{\circ} 40' 20''$ and $29^{\circ} 55' 55''$ south, longitude $30^{\circ} 50' 03''$ east and the Indian Ocean (Figure 1).

Low rolling hills characterise most of the study area, with the terrain varying in altitude from sea level along the eastern boundary to over 350 m above sea level in Chatsworth, a distance of approximately 15 km. A major topographic feature of the area is the steep-sided sand ridge known as the Bluff Ridge. This ridge stands over 80 m (maximum height 108 m) in altitude and diverges from the normal line of the coast at an angle of about 14

degrees (Preston-Whyte 1980). Inland and parallel to the Bluff Ridge is a second, smaller ridge with a maximum height of 91 m above sea level, which is often regarded as part of the Bluff Ridge (Preston-Whyte 1980; King 1982). For the purposes of this study this ridge was regarded as a distinct land form and referred to as the Wentworth Ridge (Alexander 1987). Both the Bluff and the Wentworth Ridge trend in a southwest to northeast direction.

West of the Bluff and Wentworth Ridges, a third ridge, known as the Berea Ridge, parallels the coast and rises to about 130 m (maximum height 151 m above sea level) in altitude. Natal Bay, about which the city of Durban has grown, lies between these two sets of ridges and is enclosed by a curved spit which extends from the Umgeni River estuary to the Point, and never exceeds 6 m in altitude (King & Maud 1964). The floor of the corridor between the ridges is flat and low-lying and consists largely of alluvial deposits from rivers draining into the bay. These rivers have entrenched deep, youthful valleys through the Berea Ridge but the coast of the Bluff Ridge is unbroken in the bay area (Preston-Whyte 1980).

West of the Berea Ridge, away from the foreshore and central city area, the terrain rises rapidly and becomes progressively more rugged towards the interior (King & Maud 1964). Here a low-lying hill and valley region slopes up to interfluvial crests separated by the entrenched east-west valleys (Preston-Whyte 1980) of the Umlaas, Umhlatuzana, Umbilo and Umgeni Rivers. The valley sides of these major rivers are steep, and where they cross Natal Group Sandstone, gorges have been formed. These large rivers have greatly influenced the topography of the study area (Cawood 1980).

The geological units found within the study area are considerably diverse and are discussed in detail by King & Maud (1964). Archaean granite-gneiss underlies the whole of the study area and is unconformably overlain by: the arenaceous Natal Group Sandstones; the glacial Dwyka Series and the argillaceous and arenaceous Pietermaritzburg Shale and Vryheid Formations, both of the Karoo sequence. There are several minor intrusions (dykes and sills) of Karoo Dolerite scattered throughout these formations. All other geological formations within the Durban area have accumulated during the Quaternary Era. These are: the Bluff Sandstones; the Berea Red Sand and boulderbed; and sundry unconsolidated sand, grit and clay associated with the harbour and city area; with alluvia along the major river courses (King & Maud 1964).

The range of soils found in the Durban area is linked not only to the nature of the parent geological material from which they are derived, but also to the topography of the land. The soils represented include: Arcadia Rydalvale, Cartref Cartref, Dundee Dundee, Fernwood Fernwood, Glenrosa Williamson, Hutton Clansthal, Katspruit Katspruit, Kroonstad Avoca, Kroonstad Mkambati, Longlands Waldene, Milkwood Milkwood, Mispah Mispah, Rensburg Phoenix, Shortlands Shortlands and Swartland Swartland (MacVicar *et al.* 1977).

According to Acocks (1988) the study area contains elements of both Coastal Forest and Thornveld (Veld Type

1) and Valley Bushveld (Veld Type 23), but both have been badly disturbed by the process of urbanisation. The climate in Durban is generally warm and humid with a wet summer season, but with some form of precipitation in all seasons (Cawood 1980). The main form of precipitation is rain, with an average of between 1 000 mm and 1 250 mm per annum (Preston-Whyte 1980). According to Köppen's classification (Schulze 1947), Durban falls within the C_{fw} unit. The mean annual temperature is 20.5°C with an annual range of 8.3°C (Preston-Whyte 1980).

METHODS

The Braun-Blanquet method of sampling and synthesis followed in the study is described by Westhoff & Van der Maarel (1973), Mueller-Dombois & Ellenberg (1974) and Werger (1974).

The study area was stratified into physiognomic-physiographic units using 1:1 750 aerial photography. Sampling intensity was determined using the relationship between mapping scale, vegetation structure and floristic community described by Rutherford & Westfall (1986). Sample sites were located by means of random co-ordinates within each physiognomic-physiographic unit identified. A total of 345 sample sites, each of 113 m² (as determined by Rutherford & Westfall's (1986) proposed relationship between mapping scale and smallest mappable unit area) were sited in homogeneous stands representing the different physiognomic-physiographic units.

At each sample site all plant species were listed together with their Domin-Krajina cover abundance values and growth forms. The total canopy cover and height range of each stratum of vegetation was also recorded for the purpose of physiognomic-structural classification (Edwards 1983). The environmental parameters recorded were altitude, aspect, slope, geological formation and lithology, soil texture, soil depth, soil form and series, geomorphology and land use.

The vegetation was classified according to the Braun-Blanquet method using the PHYTOTAB program package (Westfall *et al.* 1982; Westfall & De Wet 1988). The main environmental factors influencing the communities were derived from gradients determined by an ordination of floristic data by detrended correspondence analysis (DCA) (Hill & Gauch 1980) using the DECORANA program (Hill 1979). Species diversity for each community was expressed as a function of average species number per relevé/area of the relevé. Furthermore, because of the significant impact of alien invasive species on the plant ecology of municipal Durban, figures for percentage occurrence and average cover of the two predominant species: *Chromolaena odorata** and *Lantana camara** are recorded for all community types. (**Note:** * denotes alien species).

Community structure is illustrated by means of layer diagrams (Ito 1979) whereby vegetation height classes are grouped into three strata, namely a herb/grass stratum (0–0.5 m), a shrub stratum (0.5–5.0 m) and a tree stratum (>5.0 m), and determining the highest mean percentage cover in each stratum. The following symbols, determined

by the highest mean cover in a stratum, are used to classify each layer diagram type.

Layer diagram type	Cover of strata
L-type	herb>shrub>tree
rL-type	herb<shrub<tree
D-type	herb<shrub>tree
C-type	herb>shrub<tree
I-type	herb=shrub=tree

RESULTS

Classification of the vegetation, according to the Braun-Blanquet method, revealed 18 plant communities within five major vegetation types. Communities are named according to the preliminary rules and recommendations for a standardised South African syntaxonomic nomenclature system proposed by the South African Syntaxonomic Nomenclature Committee (Scheepers *et al.* unpubl.). Each name comprises a diagnostic species followed by a dominant species and a physiognomic structural term (Edwards 1983). Because of the highly disturbed nature of most of the remnant plant communities found within the Durban area, it is not possible to assign a single physiognomic structural term to many of the groupings described. A long history of disturbance, varying spatially, temporally and in intensity, has produced a mosaic of structural types within each distinct floristic grouping. In order to accommodate this variation and give a truer representation of the nature of the plant communities involved, each community is described as a physiognomic mosaic where appropriate. Edwards' (1983) structural classification makes provision for this through the use of / 'where straddling of height classes occurs' and // 'where mosaics of classes are found'.

The phytosociological classification of communities is shown in the synoptic Appendix (p. 304). Diagnostic species are listed in groups 1–45, and non-diagnostic and infrequent species in groups 46–52**. The taxa on the left of the matrix, are grouped into simplified lifeform classes to facilitate 'veld condition' assessment (Westfall *et al.* 1983); the life form classes are based on Dyer's (1976) description of the genera of South African flowering plants.

In cases where various life forms, such as trees and shrubs have adopted a scandent growth form, these are referred to as climbers. A distinction is also made *within* species in terms of developmental stage; with seedlings, saplings and fully grown forms of each species being clearly differentiated from one another. In instances where plants could not be identified beyond the generic level, the epithet sp. is appended (e.g. *Ipomoea* sp.). It should be noted that such a name may not necessarily refer to a consistent species concept, but may include various species within the genus. The structural classification of each community together with appropriate layer diagram type is shown in Figure 2.

** complete phytosociological tables for both the diagnostic species and the non-diagnostic species are available from the author or Dr R.H. Westfall, Agricultural Research Council, Rooideplaas Grassland Institute, Private Bag X05, Lynn East 0039, Pretoria.

DESCRIPTION OF THE PLANT COMMUNITIES

In the community descriptions woody and herbaceous species are both listed in order of constancy followed by mean percentage cover, with the respective values indicated next to each species. The general species characteristics of each community are omitted from the community descriptions because they are directly apparent from the Appendix (p. 304). Where species occurrences have special significance, however, these are noted.

MANGROVE FOREST

Community 1: *Avicennia marina*–*Bruguiera gymnorhiza* Mangrove Short Forest (Figure 3)

This short mangrove forest (Edwards 1983) is found along the Natal coast in bays, lagoons and at river mouths where suitable mudflats occur (0–5 m). It is represented by relevés 11, 13, 14, 201 and 202, with 2–5 species per relevé. This short forest community has a rL structure (Ito 1979; Figure 2A) with the greatest average cover of 51.6% in the upper height class of higher than 5 m. The two lower height strata are comprised almost exclusively of the saplings and seedlings of the three dominant tree species.

Habitat

The soils are of the Fernwood Form, Fernwood Series and are derived from grey sands of the Berea System and recent alluvial deposits. The terrain is generally flat with a slight easterly (Beachwood Nature Reserve) or westerly (Bayhead mangroves) aspect.

Floristics

The community is diagnosed by the *Avicennia marina* species group (Appendix .1), and has no species in common with any other species group listed in the Appendix. The character species for this group consist exclusively of three halophytic mangrove tree species: *Avicennia marina*, *Bruguiera gymnorhiza* and *Rhizophora mucronata*. The species diversity per unit area for this community is therefore low, with an average of 0.03 species per m², and an average of three species per relevé.

Trees and shrubs

	% Occurrence	Mean cover
<i>Chromolaena odorata</i> * (shrub)	0.0%	0.0%
<i>Lantana camara</i> * (shrub)	0.0%	0.0%

Conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing this community are:

<i>Avicennia marina</i> (tree)	100.0%	45.8%
<i>Bruguiera gymnorhiza</i> (tree)	100.0%	38.6%
<i>Rhizophora mucronata</i> (tree)	60.0%	20.4%

Herbs

The only herb species present in more than 20% of the relevés representing the community is:

Arthrocnemum perenne (undershrub) 20.0% 0.002%
(non-diagnostic)

The presence of this genus as the only representative of the herb stratum (other than seedlings of the three dominant tree species) indicates the saline, mesic conditions experienced in this community.

Saplings and seedlings

Saplings and seedlings occurring in more than 20% of the relevés representing the community are:

<i>Bruguiera gymnorhiza</i> sapling (tree) (non-diagnostic)	20.0%	18.2%
<i>Avicennia marina</i> seedlings (tree)	40.0%	10.4%
<i>Bruguiera gymnorhiza</i> seedlings (tree)	40.0%	7.4%
<i>Rhizophora mucronata</i> seedlings (tree)	40.0%	6.4%

General

Community 1 is floristically unrelated to any of the other vegetation types identified within the study area, and thus shares no common species groups with any of the

other communities. It is equivalent to Acocks's (1988) Mangrove Forest, Moll's (1976) Mangrove Swamp and allied communities and Ward's (1980) Mature Mangrove Communities.

Because of its floristic isolation, and the fact that this community depends entirely on within-community dynamics for long-term survival, the mangroves are considered to have a high conservation status. This ranking is further re-inforced by the restricted occurrence of this community within the municipal Durban area. Only two sites remain: the first and largest at Beachwood Nature Reserve, and the second in a limited area on the mudflats of Durban Bay to the west of Salisbury Island. A small, threatened community occurs at the Isipingo Lagoon, just outside of Durban. If these remaining sites are lost, there is little or no potential for re-establishment of similar communities elsewhere in the municipal area due to loss of suitable habitat.

The ecological autonomy of this vegetation type may be attributed to the specific habitat requirements of the community (Hutchings & Saenger 1987). Mangroves

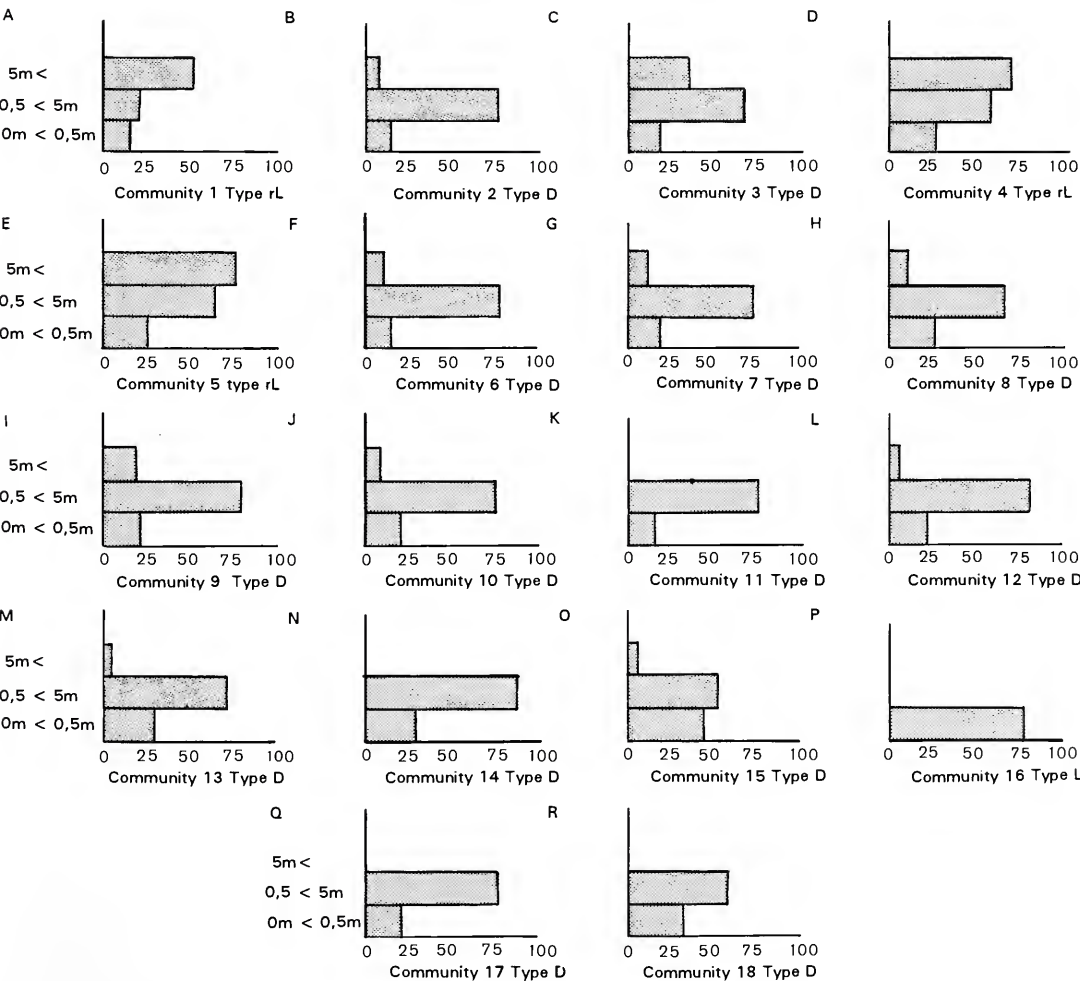


FIGURE 2.—Average community structure of the vegetation of municipal Durban, showing height classes, strata, mean percentage cover and layer diagram types (see Methods).



FIGURE 3.—Community 1: *Avicennia marina*-*Bruguiera gymnorhiza* Mangrove Short Forest. Note continuous canopy of *Avicennia marina* and large number of establishing *Avicennia marina* propagules in foreground. Location: Bay-head Mangroves.

occur only on shores where the vigour of the surf is broken by sand bars or coral reefs or islands (White 1983). This niche is effectively unavailable to plant species other than the specifically adapted halophytes which occupy it. As a result the mangrove community has the lowest species diversity of all the communities described in this study (Figure 4). The extreme environmental conditions have also prevented invasion by *Chromolaena odorata** and *Lantana camara** (Figures 5 & 6), the two most important invasive alien species in Natal (Macdonald & Jarman 1985).

The rL structure illustrated in the structure diagram (Figure 2A) is a product of these environmental restraints, as the limit placed on the number of species capable of surviving in these areas means that the community is dominated exclusively by the three mangrove tree species, *Avicennia marina*, *Bruguiera gymnorhiza*, *Rhizophora mucronata*. This produces a community structure characterised by a single layer of trees with little or no understorey. The cover within the 0.5–5.0 m category is made up of saplings and young individuals of the three tree species. Seedlings and/or saplings for all three dominant tree species were recorded only within the relevés sampled at Bayhead in the harbour.

COASTAL FOREST COMPLEX

Community 2: Transitional *Eugenia capensis*-*Maytenus procumbens* High Closed Shrubland (Figure 7)

This high closed shrubland/low thicket community mosaic (Edwards 1983) is found between 5 and 75 m above sea level. It is represented by seven relevés (Appendix) with 4–10 species per relevé. This community has a D structure (Ito 1979; Figure 2B) with the greatest average cover of 75.3% in the 0.5–5.0 m height class.

Habitat

The soils are of the Fernwood Form, Fernwood Series, and Hutton Form, Clansthal Series. The latter occur in the two atypical relevés found within this community, 205 and 219, and should not be regarded as characteristic. The terrain varies from flat to a slope of 26.6°. Aspect is also variable, with all points of an eight-point rose equally represented except for north, northeast and southwest.

Floristics

This community is differentiated by the absence of character species. The species diversity per unit area is low and averages 0.06 species per m² for the community, with an average of 6.6 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

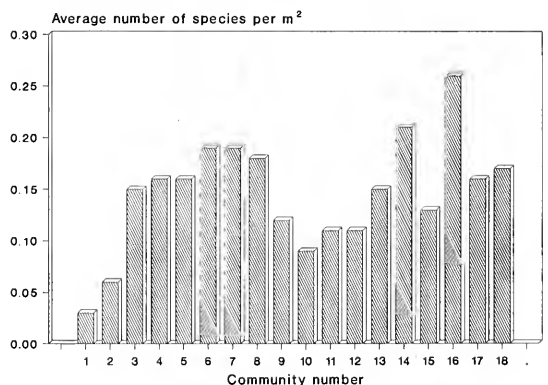


FIGURE 4.—Species diversity for Communities 1–18.

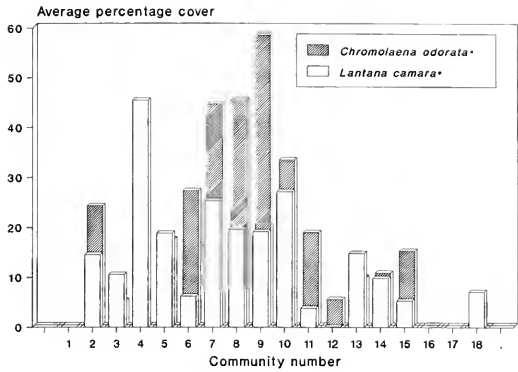


FIGURE 5.—Average percentage cover of *Chromolaena odorata** and *Lantana camara** in Communities 1–18.

<i>Chromolaena odorata*</i> (shrub)	42.9%	23.9%
<i>Lantana camara*</i> (shrub)	28.6%	14.6%

Conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing this community are:

<i>Ficus burtt-davyi</i> (shrub)	28.6%	23.9%
<i>Rhus nebulosa</i> (shrub)	28.6%	14.6%
<i>Albizia adianthifolia</i> (tree)	28.6%	8.1%

Herbs

There are no herb species occurring in more than 20% of the relevés representing the community.

Climbers

The only climber present in more than 20% of the relevés representing the community is:

<i>Rhoicissus digitata</i> (shrub)	28.6%	28.6%
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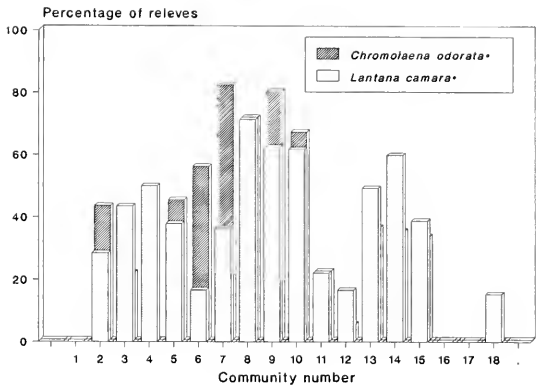


FIGURE 6.—Percentage of relevés in Communities 1–18 in which *Chromolaena odorata** and *Lantana camara** were recorded.

General

The majority of the relevés constituting this community occur in the frontal section of the secondary dunes (Tinley 1985) and are floristically equivalent to Tinley's (1985) Scrub-Thicket Community, Cawood's (1980) Dune Scrub and Ward's (1980) Closed Dune Scrub. Acocks (1988) does not recognise this as a separate community and describes this formation as part of the Dune Forest unit.

According to the classification presented in this study, also included within this community are two relevés (205 and 219) comprised predominantly of dense stands of the two invasive species *Chromolaena odorata** and *Lantana camara**, situated well inland of the secondary dune area. Although these relevés are floristically different from those located within the dune area, they are similar in terms of cover, structure, density and species richness. For the purposes of community description, the frontal dune scrub/thicket community (Moll 1976; Tinley 1985) repre-



FIGURE 7.—Community 2: Transitional *Eugenia capensis*–*Maytenus procumbens* High Closed Shrubland. Note wind-clipped, compact, even canopy of closed frontal dune communities (in the middle and background) containing *Eugenia capensis*, *Maytenus procumbens* and *Rhus nebulosa*. Dune pioneer *Scaevola thumbergii* (of the Strand community) in foreground. Location: Virginia Beach.

sented by Community 2 (excluding the atypical relevés) could be more accurately described as *Eugenia capensis*–*Maytenus procumbens* High Closed Shrubland rather than as a transitional group as indicated in the Appendix.

Community 2 is related to Community 3 through the shared presence of the *Eugenia capensis* species group (Appendix .3), and to Communities 3 and 5 through the shared presence of the *Ficus burtt-davyi* species group (Appendix .9), this indicates a common indigenous shrub element throughout all three communities. Its association with the other vegetation complexes is limited to generalist species groups (both indigenous and alien) that are ubiquitous throughout the study area, and is the result of the presence of the two atypical relevés already noted. The strong floristic relationship between Communities 2, 3 & 5 is the first indication that the community spectrum should be treated as the fundamental unit for conservation. This implies that it is insufficient merely to preserve a single area of each community type without preserving ecological/physical continuity with viable examples of the associated types.

As with the mangroves, the species diversity in the frontal dune area is restricted by the severe environmental conditions to which the community is exposed (Ward 1980). The diversity of the frontal dune communities is, however, higher than in the mangroves (Figure 4). The presence of *Chromolaena odorata** and *Lantana camara** in this community (Figures 5 & 6) is due only to the inclusion of the two atypical relevés, although Cawood (1980) and Ward (1980) both note that *Lantana camara** is an important invasive species in areas of disturbance in the frontal dune community. In this community a D structure predominates (Figure 2B), and is the result of the 'salt-spray factor' which produces a clipped-hedge appearance (Ward 1980). The predominant structural stratum in this community therefore falls within the 0.5–5.0 m category. The existence of a cover value in the greater than 5 m category, is the result of relevés sampled further

inland, here 'as the scrub-thicket matures it provides increasing protection and humus, with patches of uneven canopy in lee sites and hollows' (Tinley 1985).

Community 3: *Mimusops caffra*–*Allophylus natalensis* Low/Short Thicket (Figure 8)

This low/short thicket community (Edwards 1983) is found between 5 and 142 m above sea level. It is represented by 23 relevés (Appendix) with 7–26 species per relevé, and has a D structure (Ito 1979; Figure 2C) with the greatest average cover of 68.9% in the 0.5–5.0 m height class.

Habitat

The soils are mainly of the Fernwood Form, Fernwood Series (8 relevés) and Hutton Form, Clansthal Series (13 relevés). However, the two relevés located within Stainbank Nature Reserve have soils of the Cartref Form, Cartref Series and Kroonstad Form, Mkambati Series. The terrain varies from flat to a slope of 45°. The aspect of the land in each of the relevés is also variable, with all points of an eight-point rose represented except northeast. The southeasterly aspect is the most common, and found in six out of the 23 relevés.

Floristics

This community is differentiated by the *Mimusops caffra*–*Allophylus natalensis* species group (Appendix .2). The species diversity averages 0.15 species per m² with an average of 14.1 species per relevé. A notable feature of this community is that 47.1% of the diagnostic species for this community are either seedlings or saplings.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:



FIGURE 8.—Community 3: *Mimusops caffra*–*Allophylus natalensis* Low/Short Thicket. Note the lack of large trees or forest patches. Predominant is a thicket of *Brachylaena discolor*, *Chrysanthemoides monilifera*, and *Strelitzia nicholai*, interspersed with representatives of *Allophylus natalensis* and *Mimusops caffra*. *Chromolaena odorata** and *Lantana camara** in foreground indicate previous disturbance. Location: southeastern Bluff slopes.

<i>Lantana camara</i> * (shrub)	43.5%	10.6%
<i>Chromolaena odorata</i> * (shrub)	21.7%	4.9%

Conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community are:

<i>Brachylaena discolor</i> (shrub/tree)	39.1%	29.7%
<i>Minusops caffra</i> (tree)	21.7%	7.8%
<i>Ficus burtt-davyi</i> (shrub)	21.7%	6.3%
<i>Bequaertiodendron natalense</i> (tree)	21.7%	6.2%

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Isoglossa woodii</i> (forb/undershrub)	47.8%	24.9%
<i>Cyperus albostratus</i> (sedge)	21.7%	0.5%

Climbers

Climbers occurring in more than 20% of the relevés representing the community are:

<i>Rhoicissus rhomboidea</i> (shrub)	34.8%	30.5%
<i>Cynanchum obtusifolium</i> (climber)	30.4%	13.0%
<i>Cyphostemma hypoleucum</i> (forb)	26.1%	4.4%
<i>Flagellaria guineensis</i> (climber)	21.7%	13.1%
<i>Dalbergia obovata</i> (tree)	21.7%	2.2%
<i>Monanthes affra</i> (shrub)	21.7%	0.5%

Saplings and seedlings

The only sapling occurring in more than 20% of the relevés representing the community is:

<i>Deinbollia oblongifolia</i> sapling (tree)	39.1%	0.04%
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General

This community can be equated with Acocks's (1988) and Moll's (1976) Dune Forest, Tinley's (1985) Thicket/Forest Community and Ward's (1980) *Minusops caffra* Woodland. Within the study area no significant patches of forest remain due to previous logging of the larger trees for building poles and fuelwood (Ward 1980; Director Parks, Beaches and Recreation Department 1989). To a large extent the community is dominated by heliophytic thicket elements such as *Minusops* and *Brachylaena* with a significant creeper component (Moll 1976; Tinley 1985). The dense tangle of creepers, climbers, scandents and woody lianas which entwine the canopy is one of the most striking features of this community. These creepers are most abundant on the margins of thicket/forest, in openings where the canopy is light and especially in secondary habitats.

Moll (1976) (also Ward 1980) notes that 'much of the high density of these lianas can be attributed to recent disturbance, particularly where *Flagellaria* is present.' The predominance of *Brachylaena discolor* over large areas of this community can also be attributed to previous damage and disturbance (Moll 1976). Based on his observations at Isipingo during the period 1949–1960, Ward (1980) concluded that *Allophylus natalensis* and *Brachylaena discolor*, both characteristic species in this community, are not tolerant of deep shade, and unless there is disturbance, do not occur in the Dune Forest proper. The fact that

47.1% of the diagnostic species for this community are either seedlings or saplings indicates that regeneration is a significant aspect of this community's dynamics, and could also be related to prior disturbance.

Communities 2 and 3 are clearly related through the common presence of the *Eugenia capensis* species group (Appendix .3) and the *Ficus burtt-davyi* species group (Appendix .9). The latter also shows floristic associations with Community 5. The association between Communities 2 & 3 indicated by the *Eugenia capensis* species group (Appendix .3), is dependent on the fact that these two groups form the dune component of the Coastal Forest Complex. Together they represent a gradation from the high closed shrubland of the foredunes through to the low/short thicket of the backdunes.

The affinities of the *Ficus burtt-davyi* species group (Appendix .9) indicate that the dune components of the complex are not floristically isolated from the inland components of the Coastal Forest Complex, represented here by Community 5. This strong floristic association is confirmed by the fact that relevés in Seaton Park, Burman Bush and Stainbank Nature Reserve, traditionally regarded as areas of coastal forest as opposed to dune forest (Moll 1976; Cawood 1980) occur in Community 3; whereas of the 18 relevés located on the Bluff Ridge's seaward facing slopes (typically regarded as dune forest), 12 are grouped within the dune component (Community 3) and six within the coastal component (Community 5). This confirms the existence of a vegetation continuum in the Coastal Forest Complex, as opposed to the existence of totally distinct and separate community types, and has obvious implications for conservation planning. The coastal forest samples included within Community 3 form a distinct floristic subgroup (Appendix) not dominated by *Minusops caffra* and *Allophylus natalensis* which are regarded as indicator species for Dune Forest (Acocks 1988); this subgroup serves to indicate the unambiguous links between these two groups and reinforces the need for a landscape approach to conservation (Forman & Godron 1986).

This floristic association between Communities 3 & 5 is the result of the distribution of differential species which are widespread within the coastal areas of the urban landscape e.g. *Deinbollia oblongifolia* (Appendix .8) and *Ficus burtt-davyi* (Appendix .9) and a variety of scandent forms such as *Rhoicissus rhomboidea* (Appendix .8) and *Flagellaria guineensis* (Appendix .8). This compares with the diagnostic species which distinguish communities, and have a more limited distribution e.g. *Minusops caffra* (Appendix .2) and *Protorhus longifolia* (Appendix .6). Both diagnostic and differential species are critical to the identity and continued viability of the communities and must be catered for in conservation programs. This implies the need for large core areas to protect localised diagnostic species populations, with provision for continuity between these cores to allow free dispersal of the differential species groups which provide the broader-level ecological continuity across the urban landscape. This is totally compatible with the recommendations of Reticular Biogeography (Roberts 1990), used in the design of the municipal Durban open space system.

In Community 3 there is a marked increase in species diversity in comparison to Community 2. This is probably due to the more favourable and sheltered environmental conditions which prevail further inland (Figure 4). The average cover and percentage occurrence of *Lantana camara** is greater than *Chromolaena odorata**, although compared to the levels of these two species in other wooded communities, the absolute values are comparatively low (Figures 5 & 6). In this community too, the effect of salt-spray also affects physiognomy. This accords with the D structure evident for this community (Figure 2C) where there is a strong representation in the 0.5–5.0 m layer, but a greater percentage cover in the >5 m category than evident in Community 2.

Community 4: *Manilkara discolor*–*Tricalysia lanceolata* Short Thicket (Figure 9)

This short thicket community (Edwards 1983) is found at altitudes between 70 and 133 m above sea level. It is represented by relevés 167, 297, 299 and 309 with 13–20 species per relevé. This community has an rL structure (Ito 1979; Figure 2D) with the greatest average cover of 71.0% in the upper height classes of greater than 5 meters.

Habitat

The soils are of the Cartref Form, Cartref Series (3 out of 4 relevés) and Kroonstad Form, Mkambati Series. The terrain slopes from 1.4° to 39.8° in a generally easterly direction (only one of the four relevés has a westerly aspect).

Floristics

This community is differentiated by the *Manilkara discolor* species group (Appendix .4). The species diversity per unit area averages 0.16 species per m² for the community with an average of 18.3 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Lantana camara</i> * (shrub)	50.0%	45.5%
<i>Chromolaena odorata</i> * (shrub)	0.0%	0.0%

Conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community are:

<i>Monanthotaxis caffra</i> (shrub)	75.0%	9.3%
<i>Canthium inerme</i> (tree)	50.0%	6.5%
<i>Tricalysia lanceolata</i> (shrub/tree)	50.0%	6.5%
<i>Protorhus longifolia</i> (tree)	25.0%	22.8%
<i>Baphia racemosa</i> (tree)	25.0%	6.5%
<i>Bambusa</i> sp.* (grass)	25.0%	19.0%
(non-diagnostic)		

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Cyperus albostratus</i> (sedge)	50.0%	0.3%
<i>Panicum laticomum</i> (grass)	25.0%	19.0%
<i>Isoglossa woodii</i> (forb/undershrub)	25.0%	12.8%

<i>Panicum maximum</i> (grass)	25.0%	8.5%
<i>Dicliptera heterostegia</i> (forb)	25.0%	0.03%
<i>Vernonia angulifolia</i> (forb)	25.0%	0.03%
<i>Phaulopsis imbricata</i> (forb)	50.0%	19.3%
(non-diagnostic species)		

Climbers

Climbers occurring in more than 20% of the relevés representing the community are:

<i>Dalbergia obovata</i> (tree)	75.0%	75.0%
<i>Uvaria caffra</i> (shrub)	75.0%	1.8%
<i>Dioscorea cotinifolia</i> (climber)	50.0%	50.0%
<i>Dalbergia armata</i> (tree)	50.0%	25.0%
<i>Protaspargus falcatus</i> (climber)	50.0%	0.03%
<i>Entada spicata</i> (shrub)	25.0%	25.0%

Saplings and seedlings

Saplings and seedlings occurring in more than 20% of the relevés representing the community are:

<i>Cussonia spicata</i> sapling (tree)	75.0%	2.8%
<i>Manilkara discolor</i> sapling (tree)	75.0%	0.3%
<i>Drypetes arguta</i> sapling (tree)	50.0%	0.03%
<i>Tricalysia lanceolata</i> sapling (shrub /tree)	50.0%	0.03%
<i>Euclea natalensis</i> sapling (tree)	50.0%	0.03%
<i>Melia azedarach</i> * seedlings (tree)	25.0%	1.5%
<i>Dalbergia obovata</i> sapling (tree)	25.0%	0.3%
<i>Albizia adianthifolia</i> sapling (tree)	25.0%	0.03%
<i>Strelitzia nicolai</i> sapling (tree)	25.0%	0.03%
<i>Dalbergia armata</i> seedlings (tree)	25.0%	0.3%
(non-diagnostic)		

General

Within the complex of coastal forest communities, Community 4 emerges as a distinct unit, which, because of its specific floristic relationships and characteristics can be separated from the community spectrum created by Communities 2, 3 & 5. Community 4 is related to Community 3 through the common presence of the *Tricalysia lanceolata* species group (Appendix .5), and to Community 5 via the common presence of the *Psychotria capensis* species group (Appendix .7), and to both 3 and 5 through the shared presence of the *Rhoicissus rhomboidea* species group (Appendix .8). This latter group indicates floristic similarity at the subcanopy level between these three communities. The floristic relationships shared by Communities 3 & 4 and by Community 4 & 5 suggest the presence of a distinct dune and coastal element in Community 4. The association with Community 5 is the more significant of the two, and is reinforced by the fact that the affiliation between Community 3 and 4 in the *Tricalysia lanceolata* species group (Appendix .5) is a result of the floristic similarities shown between the subgroup of coastal forest relevés incorporated into Community 3, and the relevés constituting Community 4.

This pattern reveals strong, but selective, floristic associations between Community 4 and the remainder of the communities constituting the Coastal Forest Complex. It shares distinct floristic ties with both Communities 3 & 5, but shows no similar association with Community 2 as indicated by its absence from the *Ficus burtt-davyi* species group (Appendix .9). This is noticeably different from Communities 3 & 5 which show clear floristic links with Community 2, and indicates that the indigenous shrub component shared by Communities 2, 3 & 5 is not present



FIGURE 9.—Community 4: *Manilkara discolor*–*Tricalysia lanceolata* Short Thicket. Canopy composed of *Albizia adianthifolia*, *Canthium inerme*, *Combretum kraussii*, *Manilkara discolor*, *Protorhus longifolia* and *Strelitzia nicotai*. Location: Silverglen Nature Reserve.

in Community 4. The only association between Community 2 & 4 occurs at the most generalised floristic level through the *Chaetacanthus burchellii* species group (Appendix .45). This group contains only generalistic and opportunistic species, (both alien and indigenous) and even here there would have been no association if it had not been for the two anomalous relevés included in Community 2. Although these patterns could in part be an artifact of undersampling (Community 4 is identified by only four sample sites), the relationship between the dune and coastal forest communities is certainly far more complex and inter-related than previously documented (Moll 1976; Cawood 1980; Ward 1980).

The close floristic associations between Communities 2, 3, 4 & 5 re-emphasise the need for any urban open space system to conserve a landscape continuum rather than single examples of each community type. This approach, however, is a complex one. Variations within the continuum, such as that provided by Community 4, complicate conservation planning because of the biased importance of some floristic links, e.g. the coastal association (Community 5) is more critical to Community 4 than the dune communities (Communities 2 & 3). Yet because dune species are essential to the continued identity and viability of Community 5, ultimately it is not possible to preserve Community 4 without preserving viable communities of Community 2, 3 & 5, even though the floristic associations between Community 4 and Communities 2 & 3 are relatively limited.

Community 4 also shows specific floristic associations outside of the Coastal Forest Complex with the Valley Bushveld Complex through the *Canthium inerme* (sapling) species group (Appendix .12). This is less exclusive than the relationships with Communities 3 & 5. This association reinforces the link between Communities 4 & 5, while de-emphasising the dune connection even further, as Communities 6 & 7 of the Valley Bushveld Complex have no

floristic links with Community 2. They are, however, clearly floristically associated with Communities 3 & 5, e.g. through the *Calpurnia aurea* species group (Appendix .16). The exact implications of these community relationships are as yet unclear, but field observations of Community 4 indicate that the result is a mix of species typical of coastal forest and valley bushveld, with the coastal forest element predominant.

This observation is supported by the fact that the areas occupied by Community 4, i.e. Silverglen and Welbedacht, have traditionally been regarded as a botanical transition zone (Cawood 1980; Moll 1976). The existence of such transition areas reinforces the need to ensure ecological continuity between community complexes in order to ensure long-term viability. Any conservation system must therefore make provision not only for the linking of community types, but also for the linking of community complexes, in order to accommodate the natural complexity of floristic associations.

There is only a slight increase in diversity between Communities 3 and 4 (Figure 4). The average cover and percentage occurrence of *Lantana camara** is again greater than *Chronolaena odorata** (Figures 5 & 6). This latter observation may, however, also be a result of the fact that this community was undersampled, as may be the fact that the average cover shown by *Lantana camara** is the highest percentage obtained for any community. The presence of *Lantana camara** does, however, indicate extensive disturbance as a factor in this community.

Other important features of this community are the well-developed herb layer, a large sapling and seedling component and the frequency of creepers and climbers. Both the presence of saplings in significant numbers and the proliferation of creepers and climbers such as *Dalbergia* provide an indication of past disturbance in this area and subsequent regeneration. In comparison to Com-

munity 3, the rL structure of this community (Figure 2D) indicates that the highest cover values occur within the >5 m category. Nevertheless, the cover values in the 0.5–5.0 m class are significant and can be attributed to the high sapling count and presence of *Lantana camara**, and previous removal of large trees.

Community 5: *Protorhus longifolia* (sapling)–*Psychotria capensis* Short Thicket (Figure 10)

This short thicket community (Edwards 1983) is found at altitudes of 5–124 m. It is represented by 29 relevés (Appendix) with 6–36 species per relevé. This community has an rL structure (Ito 1979; Figure 2E) with the greatest average cover 75.9% in the >5 m height class.

Habitat

The majority of the soils underlying this community are of the Hutton Form, Clansthal Series (21 relevés). The Cartref Form, Cartref Series occurs in two relevés and each of the following soil types are represented in a single relevé: Dundee Form, Dundee Series; Fernwood Form, Fernwood Series; Katspruit Form, Katspruit Series; Longlands Form, Waldene Series; Mispah Form, Mispah Series and Swartland Form, Swartland Series. The slope of the terrain varies from flat to a 51.3° slope. Aspect is variable and all eight points of an eight-point rose are represented. West and north are the two most common directions, occurring in 6 and 5 relevés respectively.

Floristics

This community is distinguished by the *Canthium obovatum* (sapling) species group (Appendix .6). The species diversity per unit area averages 0.16 species per m² for the 29 relevés with an average of 18.1 species per relevé. A significant feature of this community is that 68.4% of the diagnostic species occur as seedlings or saplings.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Chromolaena odorata</i> * (shrub)	44.8%	17.3%
<i>Lantana camara</i> * (shrub)	37.9%	18.9%

Conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés are:

<i>Psychotria capensis</i> (shrub/tree)	55.2%	5.0%
<i>Albizia adianthifolia</i> (tree)	31.0%	17.1%

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Isoglossa woodii</i> (forb/undershrub)	48.3%	30.6%
<i>Cyperus albostrigatus</i> (sedge)	34.5%	0.1%
<i>Aneilema aequinoctiale</i> (forb)	20.7%	6.2%

Climbers

Climbers occurring in more than 20% of the relevés representing the community are:

<i>Entada spicata</i> (shrub)	31.0%	21.9%
<i>Dalbergia obovata</i> (tree)	31.0%	15.6%
<i>Flagellaria gnineensis</i> (climber)	27.6%	24.4%
<i>Smilax kraussiana</i> (shrub)	27.6%	17.3%
<i>Rhoicissus rhomboidea</i> (shrub)	20.7%	10.4%
<i>Cyphostemma hypoleucum</i> (forb)	24.1%	3.5%
<i>Jasminum multipartitum</i> (shrub)	20.7%	3.5%
<i>Monanthes affra</i> (shrub)	34.5%	3.9%

Saplings and seedlings

The only sapling occurring in more than 20% of the relevés representing the community is:

<i>Deinbollia oblongifolia</i> sapling (tree)	20.7%	0.6%
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FIGURE 10.—Community 5: *Protorhus longifolia* (sapling)–*Psychotria capensis* Short Thicket. Canopy composed of *Canthium obovatum*, *Chaetocme aristata*, *Protorhus longifolia* and *Strychnos madagascariensis*. Location: Burman Bush.



FIGURE 11.—Community 6: *Rhus pentheri*–*Cussonia spicata* Low Thicket. Canopy composed of *Commiphora harveyi*, *Cussonia spicata*, *Dombeya tiliacea* and *Euphorbia triangularis*. Location: Effingham Quarries.

General

The most significant feature of this community is the high proportion of juvenile individuals of particular indigenous tree species which define it. The large sapling presence would seem to indicate past disturbance (and subsequent regeneration) as an important factor in the areas where this community type occurs. This is supported by the presence of *Albizia adianthifolia*, a known forest precursor common at forest margins and in open forest (Ward 1980; Coates Palgrave 1983), in approximately a third of the sampled sites. A large climber presence/component is also indicative of past disturbance (Moll 1976; Cawood 1980; Tinley 1985). The inclusion of relevés located in areas such as Virginia Bush within this community, which by 1931/1932 had already been totally cleared for agricultural purposes, may well account for the high number of saplings in the diagnostic group for this community, and suggests that the majority of the areas presently occupied by Community 5 consist of regenerating examples of this community, rather than less disturbed sites.

Using Acocks's (1988) species lists as a guide, this community is diagnosed by those species he identified as being characteristic of Typical Coast-belt Forest e.g. *Celtis africana*, *Chaetacme aristata*, *Ekebergia capensis* and *Protorhus longifolia*. There is also a strong floristic correlation between Moll (1976) and Ward's (1980) description of Coast Forest and the species composition of Community 5, both at the canopy and subcanopy layer.

A strong floristic link between Community 5 and the dune communities is indicated by the *Rhoicissus rhomboidea* and *Ficus burtt-davyi* species groups (Appendix .8 & .9) which are common to Communities 3, 4 & 5 and 2, 3 & 5 respectively. The *Rhoicissus rhomboidea* species complex describes the indigenous understorey species common to both the dune and coastal forest communities, while the *Ficus burtt-davyi* species group describes

a common indigenous shrub component present throughout the dune/coastal forest complex. As with Community 3, *Isoglossa woodii* is an important component of the field layer.

This strong association between the two community types implies that they cannot be treated as separate conservation entities, and must be planned and managed together. The presence of relevé 104 within Community 5, situated as it is in the back dune area, provides further confirmation of this inter-relatedness, indicating that restrictive lines drawn on vegetation maps are distinctly misleading for conservation purposes. Conservationists should be addressing the minimum critical areas of vegetation complexes rather than single community types. The *Psychotria capensis* species group (Appendix .7) alternatively describes a strong and exclusive association between Community 4 & 5, not shared by the dune vegetation (Communities 2 & 3). This is discussed in Community 4.

In Community 5, although both invasive species have approximately the same average cover (Figure 5), *Chromolaena odorata** occurs more frequently (Figure 6). The species diversity is on a par with that in Community 4 (Figure 4), and Community 5 also has a rL structure (Figure 2E), due to the presence of a clear tree canopy in most of the sampled areas. The high cover in the 0.5–5.0 m category could again in part be attributed to invasion by *Chromolaena odorata** and *Lantana camara**, and the presence of saplings.

VALLEY BUSHVELD COMPLEX

Community 6: *Rhus pentheri*–*Cussonia spicata* Low Thicket (Figure 11)

This low thicket community (Edwards 1983) is found at altitudes of 20–148 m and is associated with the larger river valleys in the area. It is represented by 18 relevés (Appendix) with 8–33 species per relevé. This community

has a D structure (Ito 1979; Fig. 2F) with the greatest average cover of 77.1% in the 0.5–5.0 m height class.

Habitat

The soils underlying this community are diverse and include the Cartref Form, Cartref Series; Glenrosa Form, Williamson Series; Katspruit Form, Katspruit Series; Kroonstad Form, Avoca Series; Milkwood Form, Milkwood Series; Shortlands Form, Shortlands Series and Swartland Form, Swartland Series. Of these the Glenrosa Williamson soils (5 relevés) and Katspruit Katspruit soils (4 relevés) are the most common. The terrain slopes from 4.8° to 39.8° in a variety of directions. All points of an eight-point compass rose are represented except east; south is the most common direction and occurs in 5 relevés.

Floristics

This community is distinguished by the *Rhus pentheri* species group (Appendix .10). The species diversity per unit area is 0.19 species per m² for the eighteen relevés with an average of 20.9 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Chromolaena odorata</i> * (shrub)	55.6%	26.9%
<i>Lantana camara</i> * (shrub)	16.7%	6.2%

Conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community are:

<i>Anastrebe integerrima</i> (tree)	33.3%	8.7%
<i>Rhus pentheri</i> (tree)	33.3%	5.9%
<i>Dombeya tiliacea</i> (tree)	22.2%	5.7%
<i>Hibiscus calyphyllus</i> (shrub)	38.9%	1.4%

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Cyperus albostratus</i> (sedge)	27.8%	3.0%
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Climbers

Climbers occurring in more than 20% of the relevés representing the community are:

<i>Uvaria caffra</i> (shrub)	44.5%	8.6%
<i>Jasminum multipartitum</i> (shrub)	38.9%	6.0%
<i>Dioscorea cotinifolia</i> (climber)	38.9%	5.6%
<i>Monanthotaxis caffra</i> (shrub)	38.9%	0.7%
<i>Rhoicissus tomentosa</i> (shrub)	38.9%	33.3%
<i>Rhoicissus digitata</i> (shrub)	27.8%	27.8%
<i>Entada spicata</i> (shrub)	27.8%	13.0%
<i>Dalbergia obovata</i> (tree)	22.2%	26.4%
<i>Scutia myrtina</i> (shrub)	22.2%	5.6%
<i>Passiflora suberosa</i> * (climber)	22.2%	0.006%

Saplings and seedlings

Saplings and seedlings occurring in more than 20% of the relevés representing the community are:

<i>Cussonia spicata</i> sapling (tree)	38.9%	0.06%
<i>Hippobromus pauciflorus</i> sapling (tree)	33.3%	1.9%
<i>Baphia racemosa</i> sapling (tree)	22.2%	0.06%
<i>Clausena anisata</i> sapling (shrub)	22.2%	0.006%

General

The relevés constituting Community 6 are located along the valley lines associated with river courses. This is similar to the distribution noted by Acocks (1988) for his Northern Variation of the Valley Bushveld, and that noted by Moll (1976) for Dry Valley Scrub and Bushland Mosaic. Floristically Community 6 corresponds well with Acocks's (1988) Veld Type 23a—the Northern Variation of the Valley Bushveld. Note the presence of species such as *Acacia robusta*, *Cussonia spicata*, *Euphorbia triangularis* and *Rhus pentheri*. It also shows varying degrees of floristic similarity with Moll's (1976) Dry valley Scrub and Bushland Mosaic (greater) and *Acacia sieberiana* Savanna (lesser).

The relationship between this valley bushveld community and the dune and coastal components of the Coastal Forest Complex, i.e. Communities 3, 4 & 5, is indicated by the common presence of the *Chaetacme aristata* species group (Appendix .11) common to Communities 5 and 6; the *Canthium inerme* sapling species group (Appendix .12) common to Communities 4, 5 & 6; and finally the *Uvaria caffra* species group (Appendix .13) shared by Communities 3, 4, 5 & 6. These species groups indicate a floristic similarity largely in the subcanopy layers between the two vegetation complexes e.g. *Brachylaena discolor* (Appendix .13) and *Rhoicissus tomentosa* (Appendix .13).

Thus, although the tree species defining the Valley Bushveld Complex are, to a large extent, distinct from those defining the various components of the Coastal Forest complex, there is still a common subcanopy element linking the two groups. This is important, as it indicates the need to establish continuous closed canopy links between the complexes. Because of the large distances separating most of the important conservation sites for Communities 3, 4, 5 & 6 within the city, corridors or stepping-stone areas capable of supporting viable wooded communities will therefore be necessary to ensure the adequate conservation and dissemination of these species, particularly where the species concerned are poor dispersers.

Although there is a large creeper representation in this community, indigenous saplings and seedlings are not as prominent a component of the community either in abundance or diagnostic importance as in Communities 4 or 5; only 30.8% of diagnostic species occur as saplings or seedlings. That disturbance is a critical feature in this community, however, cannot be doubted and is evident in the fact that this community has a higher average cover and percentage occurrence of *Chromolaena odorata** than any of the preceding woody communities. It nevertheless also has lower levels of *Lantana camara** (Figures 5 & 6).

Community 6 shows a marked increase in species diversity over that recorded for Community 5 (Figure 4). This is the highest species diversity shown by any of the wooded communities in the study. The D-structure of

Community 6 (Figure 2F) could be attributed to disturbance and invasion by *Lantana camara** and *Chromolaena odorata**, sapling establishment, previous tree felling and the drier conditions which prevail in areas occupied by Community 6.

Community 7: *Dovyalis rhamnoides*–*Hippobromus pauciflorus* Low Thicket (Figure 12)

This low thicket community (Edwards 1983) is found at altitudes of between 30 and 140 m. It is represented by 11 relevés (Appendix) with 9–31 species per relevé. This community has a D structure (Ito 1979; Figure 2G) with the greatest average cover of 73.7% in the 0.5–5.0 m height class.

Habitat

The soils of this community are widely varied and include the Cartref Form, Cartref Series; Glenrosa Form, Williamson Series; Hutton Form, Clansthal Series; Katspruit Form, Katspruit Series; Kroonstad Form, Avoca Series; Longlands Form, Waldene Series; Rensburg Form, Phoenix Series and Swartland Form, Swartland Series. The Glenrosa Williamson soils are the most common and are represented in 3 out of 11 relevés. The terrain slopes from 6.5° to 32° in a generally southerly direction (7 out of 11 relevés).

Floristics

The community is distinguished by the *Cissampelos torulosa* species group (Appendix .14). The species diversity per unit area is 0.19 species per m² for the 11 relevés, with an average of 21.4 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Chromolaena odorata</i> * (shrub)	81.8%	44.3%
<i>Lantana camara</i> * (shrub)	36.4%	25.4%

Conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community are:

<i>Hippobromus pauciflorus</i> (tree)	27.3%	9.3%
<i>Melia azedarach</i> * (tree)	27.3%	7.7%

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Cyperus albostratus</i> (sedge)	45.5%	2.9%
<i>Scadoxus puniceus</i> (forb)	36.4%	1.0%
<i>Setaria megaphylla</i> (grass)	36.4%	0.6%
<i>Panicum maximum</i> (grass)	27.3%	6.9%

Climbers

Climbers occurring in more than 20% of the relevés representing the community are:

<i>Protasparagus virgatus</i> (climber)	81.8%	0.2%
<i>Monanthes affra</i> (shrub)	36.4%	1.0%
<i>Cissampelos torulosa</i> (shrub)	27.3%	9.1%

Saplings and seedlings

Saplings and seedlings occurring in more than 20% of the relevés representing the community are:

<i>Euclea natalensis</i> sapling (tree)	45.5%	0.6%
<i>Hippobromus pauciflorus</i> sapling (tree)	36.4%	3.1%
<i>Clausena amisata</i> sapling (shrub)	36.4%	0.7%
<i>Dovyalis rhamnoides</i> sapling (shrub)	27.3%	1.6%
<i>Trimeria grandifolia</i> sapling (tree)	27.3%	0.1%
<i>Dalbergia obovata</i> seedlings (tree)	27.3%	0.2%



FIGURE 12.—Community 7: *Dovyalis rhamnoides*–*Hippobromus pauciflorus* Low Thicket. Canopy composed of *Hippobromus pauciflorus*, *Kraussia floribunda*, *Scolopia zeyheri* and *Trimeria grandifolia*. Location: Hulett's Bush.

General

In terms of species composition, Community 7 can be related to Acocks's (1988) Northern Variation of the Valley Bushveld (note the presence of species such as *Calpurnia aurea*, *Coddia rudis*, *Hippobromus pauciflorus* and *Zanthoxylum capense*) and to Moll's (1976) Dry valley Scrub and Bushland Mosaic (greater extent) and *Acacia sieberiana* Savanna (lesser extent). Community 7 is related to Community 6 through the common presence of the *Coddia rudis* species group (Appendix .15).

As with Community 6, Community 7 shows associations with the Coastal Forest Complex, in this instance through the shared presence of the *Calpurnia aurea* species group (Appendix .16) which Community 7 shares in common with Communities 3, 4, 5 & 6. The *Dovyalis rhamnoides* sapling (Appendix .17) and *Cyphostemma hypoleucum* (Appendix .18) species group are composed predominantly of indigenous saplings and provide a broad floristic association between Communities 5, 6, 7 & 8 and 3, 4, 5, 6, 7 & 8. This indicates a common level of regeneration occurring in both the Valley Bushveld and Coastal Forest Complexes, and strengthens the need for integrated conservation of all community types.

Community 7 shows a greater degree of disturbance than Community 6. This is evident in the higher values for average cover and percentage occurrence of *Chromolaena odorata** and *Lantana camara** (Figures 5 & 6), as well as the greater predominance of seedlings and saplings of various species and the widespread occurrence of the invasive *Melia azedarach** which is characteristic of early seral stages (Ward 1980). The proportional representation by climbers in this community is, however, greatly reduced. The frequency of occurrence and average cover of *Chromolaena odorata** is the highest for any of the wooded communities contained in the Coastal Forest and Valley Bushveld Complexes (Figures 5 & 6). The percentage occurrence of *Chromolaena odorata** within this community is even higher than for Community 9 which represents the badly invaded shrubland areas of Durban.

Because of the floristic similarities and the greater signs of disturbance, it could be that Community 7 is merely a more disturbed form of Community 6 (i.e. a preceding seral stage) but, without further study of the dynamics and inter-relationships of these two vegetation types, it is not yet possible to investigate this proposal more fully. It is just as likely that the broad differences in the diagnostic species of both groups indicate local variations of the valley bushveld form. This is highly probable, if one considers that Moll (1976) identified three variations in the woody communities occupying the areas equivalent to those occupied by Communities 6 and 7 in this study.

Species diversity for Community 7 is on a par with that for Community 6 and represents the highest species diversity values recorded for any of the wooded communities within the classification table (Figure 4). As with Community 6 the D structure (Figure 2G) of this community can be attributed to disturbance, shrub invasion, felling, a significant sapling layer and possibly to drier



FIGURE 13.—Community 8: Transitional. Represents an encroaching woody element into grassland communities. *Trimeria grandifolia* sapling in the middleground. The Grassland community is dominated by ruderal and secondary species such as *Eragrostis curvula*, *Digitaria* sp., *Senecio polyanthemoides* and *Sorghum bicolor*. Dense clumps of *Chromolaena odorata** and *Lantana camara** to the left indicate past disturbance. Location: Effingham Quarries.

conditions which produce a shorter canopy layer (Moll 1976).

SHRUBLAND COMPLEX

Community 8: Transitional (Figure 13)

This tall closed shrubland/low/short thicket community mosaic (Edwards 1983) is found at altitudes of 5–237 m. It is represented by seven relevés (Appendix) with 10–35 species per relevé. This community has a D structure (Ito 1979; Figure 2H) with the greatest average cover of 67.3% in the 0.5–5.0 m height class, which also contains a significant grass component.

Habitat

The soils underlying this community are varied and include the Cartref Form, Cartref Series; Fernwood Form, Fernwood Series; Hutton Form, Clansthal Series; Katspruit Form, Katspruit Series; Milkwood Form, Milkwood Series and Mispah Form, Mispah Series. None are obviously predominant. The terrain slopes from virtually flat to 51.3°, the aspect being variable and including all four points of a four-point rose, with east being the most common (3 out of 7 relevés).

Floristics

This community is differentiated by the absence of character species. The species diversity per unit area averages 0.18 species per m² for the community with an average of 19.9 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Chromolaena odorata</i> * (shrub)	71.4%	35.0%
<i>Lantana camara</i> * (shrub)	71.4%	19.6%

There are no woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Hibiscus surattensis</i> (forb)	28.6%	14.3%
<i>Eragrostis curvula</i> (grass)	28.6%	5.7%
<i>Sorghum bicolor</i> (grass)	28.6%	0.9%
<i>Senecio polyanthemoides</i> (forb)	28.6%	0.1%
<i>Digitaria</i> sp. (grass)	28.6%	0.1%
<i>Cyperus albostratus</i> (sedge)	28.6%	0.01%

Climbers

Climbers occurring in more than 20% of the relevés representing the community are:

<i>Protaspargus virgatus</i> (climber)	42.9%	0.03%
<i>Cyphostemma hypoleucum</i> (forb)	28.6%	28.6%
<i>Dalbergia armata</i> (tree)	28.6%	14.3%
<i>Dalbergia obovata</i> (tree)	28.6%	25.1%

Saplings and seedlings

Saplings and seedlings occurring in more than 20% of the relevés representing the community are:

<i>Dalbergia obovata</i> sapling (tree)	28.6%	1.6%
<i>Heteropyxis natalensis</i> sapling (tree) (non-diagnostic species)	28.6%	0.9%

General

Except for Communities 9, 12 & 17 the remainder of the floristic units represented in the Appendix cannot be equated with any of the communities described by Acocks (1988), Moll (1976), Cawood (1980) or Ward (1980). This means that prior to this study, 44% of the communities which occur in the municipal area had not been described.

Community 8 marks a transition zone from the valley bushveld communities represented by Communities 6 & 7 to the disturbed shrubland and grassland communities of the urban area. The physiognomy and floristic make-up of Community 8 indicate that it represents an encroaching woody element into the disturbed shrublands and grasslands of the Appendix represented by Communities 9 and 10. This observation is supported by the high percentage of saplings present in the *Dovyalis rhannoides* sapling (Appendix .17) and *Cyphostemma hypoleucum* (Appendix

.18) species groups, and in other species groups with representatives in this community e.g. the *Hippobromus pauciflorus* (sapling) species group (Appendix .20). All of the species concerned are indigenous, which indicates the potential for the re-establishment of natural communities in these areas. This process of regeneration could be encouraged through active management, and where necessary and appropriate such areas could be used to form links with, or to enlarge core conservation areas of the more 'pristine' communities. Another prominent species group in this community is the *Senecio polyanthemoides* species group (Appendix .39). This group is characterised by the presence of ruderal and generalist species, some of which are alien invasives. This supports the concept of an encroachment dynamic in this transition zone.

That disturbance is a prominent feature of this transition zone is evident in the high average cover and percentage occurrence of both *Chromolaena odorata** and *Lantana camara** in this community (Figures 5 & 6). Community 8 shows an equal percentage occurrence for *Chromolaena odorata** and *Lantana camara**, resulting from a decrease in *Chromolaena odorata** and an increase in *Lantana camara** as compared with Community 7 levels (Figure 6). There is a slight decrease in diversity relative to Community 7 (Figure 4), probably due to increased levels of disturbance and invasion by alien shrub species which tend to form large homogeneous stands. The D structure (Figure 2H) can also be attributed to the significant alien shrub component and an increased representation of grass species in this community.

Community 9: *Acacia gerrardii*-*Rhus chirindensis* Tall Closed Shrubland/Low/Short Thicket Mosaic (Figure 14)

This tall closed shrubland/low/short thicket community mosaic (Edwards 1983) is found at altitudes of 10–285 m. It is represented by 64 relevés (Appendix) with 2–33 species per relevé. This community has a D structure (Ito 1979; Figure 2I) with the greatest average cover of 79.8% in the 0.5–5.0 m height class. Grass is a significant component of both the 0–0.5 m and 0.5–5.0 m height class, a factor which distinguishes it from previous communities.

Habitat

The soils underlying this community are diverse and include the Cartref Form, Cartref Series; Dundee Form, Dundee Series; Fernwood Form, Fernwood Series; Glenrosa Form, Williamson Series; Hutton Form, Clansthal Series; Katspruit Form, Katspruit Series; Kroonstad Form, Mkambati Series; Longlands Form, Waldene Series; Milkwood Form, Milkwood Series; Mispah Form, Mispah Series; Rensburg Form, Phoenix Series and Swartland Form, Swartland Series. The three most common soils are the Mispah Mispah soils (in 12 relevés), Glenrosa Williamson soils (in 9 relevés) and Cartref Cartref soils (in 8 relevés). The terrain occupied by this community varies from flat at some sites to an inclination of 39.8° at others, with all eight points of an eight-point compass rose represented. Northern and southern aspects are most common, and are found in 12 and 15 relevés respectively.



FIGURE 14.—Community 9: *Acacia gerrardii*–*Rhus chirindensis* Tall Closed Shrubland// Low/Short Thicket Mosaic. Community 9 is composed predominantly of dense stands of *Chromolaena odorata** and *Lantana camara**, in this instance interspersed with specimens of *Mangifera indica**. Location: Welbedacht.

Floristics

This community is distinguished by the *Maytenus senegalensis* sapling species group (Appendix .19). The species diversity per unit area averages 0.12 species per m² for the community, with an average of 13.5 species per relevé; 47.1% of the species diagnostic for this community type occur as saplings or seedlings.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Chromolaena odorata</i> * (shrub)	79.7%	58.1%
<i>Lantana camara</i> * (shrub)	62.5%	19.2%

The only conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community is:

<i>Melia azedarach</i> * (tree)	34.4%	9.3%
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Herbs

There are no herb species occurring in more than 20% of the relevés representing the community.

Climbers

Climbers occurring in more than 20% of the relevés representing the community are:

<i>Protasparagus virgatus</i> (climber)	31.3%	0.06%
<i>Dalbergia obovata</i> (tree)	20.3%	7.7%

General

This community can be equated floristically with the 'heavily disturbed' areas described by Cawood (1980),

and is characterised by the presence of alien invasive species. Community 9 as identified within this study is dominated by three invasive species: *Chromolaena odorata**, *Lantana camara** and *Melia azedarach**, all of which indicate high levels of disturbance, and early seral communities (Ward 1980). Concurrent with dominance by alien species is the low cover and occurrence values for the indigenous herbs, saplings, seedlings and climbers which characterise this community (Sukopp & Werner 1983). This indicates a generally unfavourable environment created by the invasive species, forming stands so dense that they shade out and out-compete most indigenous species. Potential for regeneration of the indigenous cover is, however, indicated by the fact that 47.1% of the species diagnostic for this community type are saplings or seedlings of indigenous species.

The relationship of this community to the Valley Bushveld Complex and associated shrub community (6, 7 & 8) is shown through the common presence of the *Hippobromus pauciflorus* sapling species group (Appendix .20). Community 9 is also associated with the Coastal Forest Complex through the *Protasparagus virgatus* species group (Appendix .21) common to Communities 5, 6, 7, 8 & 9; and the *Isoglossa woodii* species group (Appendix .22) shared by Communities 3, 4, 5, 6, 7, 8 & 9. These broad floristic associations indicate the widely occurring nature of this invasive shrubland, elements of which can be found in areas previously occupied by all the wooded communities described, except the mangrove communities. This widespread occurrence can be linked to the broad patterns of disturbance that have characterised the urban landscape and facilitated the spread of opportunistic species such as *Chromolaena odorata** and *Lantana camara**.

It should be noted that the majority of the saplings which characterise this group would according to Acocks (1988) be typical of the Northern Variation of the Valley

Bushveld e.g. *Acacia nilotica*, *Buddleja saligna*, *Combretum molle*, *Dalbergia obovata*, *Hippobromus pauciflorus*, *Maytenus heterophylla* and *Spirostachys africana*. However, the presence of species such as *Apodytes dimidiata*, *Rhus chirindensis*, *Trema orientalis* and *Vitellariopsis marginata* also suggests a strong coastal forest element. These patterns are also reflected in the occurrence of shrubs and climbers. This is important because, by using the sapling component of these shrublands as an index, it should be possible to assess the nature of the community that existed in these areas prior to disturbance. Such an assessment is critical to the future use of disturbed areas as extensions to existing core areas and as dispersal corridors within the open space system. Not only will it provide direction for replanting schemes, but it will serve to indicate the potential effectiveness of various areas as links between different community and complex types. The presence of grass species such as *Panicum maximum* and *Eragrostis curvula* as a marked component of the 0–0.5 m and 0.5–5.0 m height class indicates that this community not only represents wooded areas which have been disturbed, but probably also represents grassland areas which have since become invaded and dominated by these shrub species.

Community 9 shows a marked drop in species diversity in comparison to Community 8 (Figure 4). This is an important characteristic of the shrubland complex, i.e. as the intensity of invasion by species such *Chromolaena odorata** and *Lantana camara** increases, so the overall species diversity within communities decreases. *Chromolaena odorata** predominates in this community and shows an increase in both cover and percentage occurrence relative to levels in Community 10 (Figures 5 & 6). In fact, this community has the highest average cover for *Chromolaena odorata** of all the communities sampled. The cover for *Lantana camara**, however, remains the same as that found in Community 10 and its actual percentage occurrence decreases. The D structure (Figure 21)

is due to the predominance of shrub and grass components in this community.

Community 10: Transitional (Figure 15)

This low/short closed grassland/tall closed shrubland/low/short thicket community mosaic (Edwards 1983) is found at altitudes of 5–230 m. It is represented by 21 relevés (Appendix) with 4–21 species per relevé. This community has a D structure (Ito 1979; Figure 2J) with the greatest average cover of 75.2% in the 0.5–5.0 m height class. This class contains a large shrub component.

Habitat

The soils underlying this community are diverse and include the Cartref Form, Cartref Series; Dundee Form, Dundee Series; Fernwood Form, Fernwood Series; Glenrosa Form, Williamson Series; Hutton Form, Clansthal Series; Katspruit Form, Katspruit Series; Kroonstad Form, Mkambati Series; Longlands Form, Waldene Series; Milkwood Form, Milkwood Series; Mispah Form, Mispah Series; Rensburg Form, Phoenix Series and Swartland Form, Swartland Series. The most common are the Glenrosa Williamson soils (4 relevés), Hutton Clansthal soils (3 relevés) and Mispah Mispah soils (3 relevés). The terrain occupied by this community varies from flat at some sites to an inclination of 22.6° at others, with all eight points of an eight-point compass rose represented except for southeast and southwest. North and east are the most common aspect, each occurring in 5 relevés.

Floristics

This community is characterised by the absence of character species, but is best represented floristically by the *Mangifera indica** species group (Appendix .23). The



FIGURE 15.—Community 10: Transitional. The presence of *Mangifera indica** (remnant of an old mango plantation) is a sign of past human disturbance, as is the presence of species such as *Chromolaena odorata**, *Lantana camara** and *Tagetes minuta**. Predominant grass species is *Panicum maximum*. Location: Newlands West, along Umgeni River.



FIGURE 16.—Community 11. *Bothriochloa insculpta*–*Hyparrhenia hirta* Short Closed Grassland. Species recorded: *Bothriochloa insculpta*, *Panicum maximum*, *Rhynchielytrum repens* and *Sporobolus africanus*. Location: Phoenix.

species diversity per unit area is 0.09 species per m² for the community with an average of 10.0 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Chromolaena odorata</i> * (shrub)	66.7%	33.0%
<i>Lantana camara</i> * (shrub)	61.9%	27.2%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.*

Herbs

There is only a single herb species occurring in more than 20% of the relevés representing the community, this is:

<i>Panicum maximum</i> (grass)	33.3%	16.7%
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Saplings and seedlings

The only sapling occurring in more than 20% of the relevés representing the community is:

<i>Psidium guajava</i> * sapling (tree)	23.8%	0.01%
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General

As with the other two communities in this complex, Community 10 is dominated by the two shrub species *Chromolaena odorata** and *Lantana camara**. This community is related to the coastal forest and valley bushveld and disturbed shrubland communities (3, 4, 5, 6, 7, 8 & 9) through the common presence of the *Mangifera indica** species group (Appendix .24). This widespread association across the table again re-emphasises the ubiquitous

nature and effects of disturbance throughout the urban landscape. Two species within species group 24, *Mangifera indica** and *Syzygium cumini**, would seem to indicate past cultivation (Indian market gardening) and residential development as a factor in disturbance. This may to a certain extent be confirmed by the presence of *Psidium guajava** seedlings within this community.

Like Community 9, Community 10 is essentially a shrubland/thicket community, but with a more prominent grassland component, suggesting that it acts as a transition between the shrublands dominated by *Chromolaena odorata** and *Lantana camara** and the disturbed grassland communities that follow on the table. Of the three communities in the shrubland complex it has the lowest species diversity (Figure 4), and is only higher on the diversity index than the mangrove and foredune communities, where exposure and harsh environmental conditions are responsible for limiting species diversity. Community 10 also sees a marked fall in the average cover and percentage occurrence of *Chromolaena odorata**, and a rise in the average cover of *Lantana camara** although its percentage occurrence is the same as in Community 9 (Figures 5 & 6). The low species diversity of this community can be associated with the extensive presence of both *Chromolaena odorata** and *Lantana camara**. As with the other disturbed communities, the D structure is due to the strong shrub component and increasingly high levels of grass with the community.

The low species diversity of this community combined with the overall predominance of ruderal, invasive and alien species, provides little indication of the indigenous regeneration noted in Communities 8 and 9. In Community 10 all trace of the previous vegetation layer has been removed and altered. Any restoration of these areas will therefore have to rely on informed guesswork, using a knowledge of the location of the area and the surrounding community types.

GRASSLAND COMPLEX

Community 11: *Bothriochloa insculpta*–*Hyparrhenia hirta* Short Closed Grassland (Figure 16)

This short/closed grassland community (Edwards 1983) is found at altitudes of 26–117 m. It is represented by 9 relevés (Appendix) with 6–19 species per relevé. This community has a D structure (Ito 1979; Figure 2K) with the greatest average cover of 74.2% in the 0.5–5.0 m height class. No vegetation above 5 m occurs in this community type.

Habitat

The soils underlying this community are of three types, the Glenrosa Form, Williamson Series; Milkwood Form, Milkwood Series and Mispah Form, Mispah Series. All are equally common. The terrain occupied by this community varies in inclination from 3.8°–26.6° in the following directions: northeast, southeast, south, northwest and north. East is the most common aspect occurring in 3 out of the 9 relevés.

Floristics

This community is distinguished by the *Bothriochloa insculpta* species group (Appendix .24). The species diversity per unit area is 0.11 species per m² for the nine relevés, with an average of 12.6 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Chromolaena odorata</i> * (shrub)	22.2%	18.6%
<i>Lantana camara</i> * (shrub)	22.2%	3.8%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Bothriochloa insculpta</i> (grass)	77.8%	27.9%
<i>Teramnus labialis</i> (forb)	66.7%	0.1%
<i>Hyparrhenia hirta</i> (grass)	33.3%	16.9%
<i>Panicum maximum</i> (grass)	33.3%	16.9%
<i>Eragrostis curvula</i> (grass)	33.3%	15.1%
<i>Sporobolus africanus</i> (grass)	22.2%	8.6%
<i>Sorghum bicolor</i> (grass)	22.2%	1.3%
<i>Physalis viscosa</i> * (forb)	22.2%	0.8%
<i>Sonchus wilmsii</i> (forb)	22.2%	0.8%
<i>Cynodon dactylon</i> (grass)	22.2%	0.7%
<i>Stachys natalensis</i> (forb)	22.2%	0.7%
<i>Rhynchosyris repens</i> (grass)	22.2%	0.2%

Saplings and seedlings

The only sapling occurring in more than 20% of the relevés is:

<i>Psidium guajava</i> * sapling (tree)	33.3%	0.01%
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General

The lack of a significant floristic association between Community 11 and the preceding communities on the Appendix, indicates a distinct floristic break between the woody components of the shrubland, thicket and forest contained in Communities 1–10, and the distinct grassland forms which begin with Community 11. The predominance of the perennial *Bothriochloa insculpta* in Community 11 indicates that the areas where this grassland occurs have generally been subjected to conditions of 'over-utilisation, trampling and bad management' (Tainton *et al.* 1976). Tainton (1981a) regards *Bothriochloa insculpta* as an Increaser II species. This is one of four possible classes:

Decreaser species: those which dominate in veld which is in good condition and which decline in abundance when veld deteriorates in condition;

Increaser I species: those which are not abundant in veld which is in good condition, but which increase when the veld is under-utilised;

Increaser II species: those which are not abundant in veld of good condition, but which increase when veld is over-utilised;

Increaser III species: those which are not abundant in the veld which is in good condition, but which increase when the veld is selectively grazed.

Other species such as *Cynodon dactylon* (Increaser II), *Eragrostis curvula* (Increaser II), *Hyparrhenia hirta* (Increaser II), *Rhynchosyris repens* (Increaser II) and *Sporobolus africanus* (Increaser II) are also good indicators of previous disturbance (particularly cultivation), over-utilisation or mismanagement (Tainton *et al.* 1976, 1981b; Ward 1980). Bayer (1955) goes so far as to describe grassland types for Natal as 'subseral grasslands of old fields'. The presence of *Panicum maximum* in significant amounts in this community, a Decreaser species, however, suggests a possible improvement in veld condition.

This is supported by Tainton *et al.* (1976) assertion that when such deteriorated veld is rested, *Bothriochloa insculpta* may increase to the extent of dominance and assist in the restoration of a 'productive cover of mixed composition'. The predominance of perennial species and species such as *Bothriochloa insculpta* in Community 11, thus indicate both good soil protection and the potential for the regeneration of a better quality and a more diverse community. These grassland sites should therefore be assigned a high conservation value. The presence of *Leucaena leucocephala** as a diagnostic species for this community and *Psidium guajava** saplings in 20% of the samples, however, indicates the potential for woody encroachment by invasive species which must be carefully monitored.

This community shows no affiliation with the coastal forest, valley bushveld or shrubland complexes except through the generalist species groups e.g. the *Tagetes minuta** species group (Appendix .35). Within the ecological/floristic gradient represented by the table, Community

11 is also clearly separated from the remainder of the grasslands in the municipal area, i.e. Communities 13 to 18, except at the most generalised levels where the association is largely due to a common level of disturbance rather than floristically meaningful interrelationships, e.g. the *Senecio polyanthemoides* species group (Appendix .39) and the *Chaetacanthus burchellii* species group (Appendix .45). The reason for this distinctiveness is difficult to ascertain, for as far as could be determined there has been no significant variation in the disturbance pattern experienced in areas occupied by Community 11 when compared with the other secondary grasslands in municipal Durban. It is therefore important that viable units of this grassland type are conserved and carefully monitored in order to clarify the causal factors underlying their floristic distinctness. Community 11 is associated with the wetlands/floodplains (Community 12) and disturbed grasslands (Community 13) through the *Mariscus sumatrensis* species group (Appendix .28). The species composition of this group, however, also suggests that this similarity is the result of a common element of disturbance, rather than the existence of a similar moisture regime.

Community 11 shows levels of *Chromolaena odorata** and *Lantana camara** well below those evident in Community 10. There is a marked decrease in both the average cover values and percentage occurrence for these species (Figure 5 & 6). This indicates an improved community condition as does the higher species diversity in this community (Figure 4). Community 11 does, however, have the highest *Chromolaena odorata** values of all the grasslands, but has the second lowest values of *Lantana camara**. Note that there is no representation in the >5 m category due to the predominant grass component which also accounts for the D structure of the community (Figure 2K).

Community 12: *Phragmites australis*-*Cyperus immensus* Short Closed Grassland//Tall/High Closed Shrubland//Tall Closed Reedbed Mosaic (Figure 17)

This short closed grassland/tall/high closed shrubland//tall closed reedbed community mosaic (Edwards 1983) occurs at altitudes of 5–55 m. It is represented by 18 relevés (Appendix), with 4–21 species per relevé. This community has a D structure (Ito 1979; Figure 2L) with the greatest average cover of 79.6% in the 0.5–5.0 m height class. Both the 0.5–5.0 m height class and the >5 m height class consists predominantly of reeds.

Habitat

The soils underlying this reedbed community are predominantly of the Dundee Form, Dundee Series; Katspruit Form, Katspruit Series and Rensburg Form, Phoenix Series. Several fill sites are also noted within this community type in areas such as the harbour and airport (i.e. areas of recent alluvial deposits). The Dundee Dundee soils are by far the most common occurring in 13 of the 18 relevés. The terrain occupied by this community varies from generally flat to an inclination of 32.0° in the following directions: northeast, east, southwest, west, northwest and north. East is the most common aspect occurring in 8 out of the 18 relevés.

Floristics

This community is distinguished by the *Phragmites australis* species group (Appendix .25). The species diversity per unit area is 0.11 species per m² for the 18 relevés, with an average of 11.8 species per relevé.



FIGURE 17.—Community 12: *Phragmites australis*-*Cyperus immensus* Short Closed Grassland//Tall/High Closed Shrubland//Tall Closed Reedbed Mosaic. Species along riverbank: *Cyperus immensus* and *Phragmites australis*. Presence of several alien invasive species in floodplain e.g. *Chromolaena odorata**, *Lantana camara** and *Schinus terebinthifolius**, and larger *Pennisetum* sp.* reeds in background. Location: Umhlanga River floodplain near the Northern Waste Water Treatment Works.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Chromolaena odorata</i> * (shrub)	5.6%	5.1%
<i>Lantana camara</i> * (shrub)	16.7%	0.06%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community. The community is otherwise dominated by reed and sedge species:

<i>Phragmites australis</i> (reed)	61.1%	20.7%
<i>Phragmites</i> sp. (reed)	38.9%	22.9%
<i>Cyperus immanis</i> (sedge)	27.8%	5.6%

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Laportea peduncularis</i> (forb)	33.3%	10.0%
<i>Ageratum conyzoides</i> * (forb)	33.3%	2.2%
<i>Senecio polyanthemoides</i> (forb)	33.3%	0.7%
<i>Panicum maximum</i> (grass)	27.8%	11.2%
<i>Commelina erecta</i> (forb)	27.8%	0.1%

Climbers

Climbers present in more than 20% of relevés are:

<i>Ipomoea cairica</i> (forb)	27.8%	22.3%
<i>Cardiospermum grandiflorum</i> * (climber)	22.2%	22.2%

General

This floristic grouping describes the wetland communities in the Durban area. The majority of the sites represented by this community are floodplain sites, as most other wetland areas in municipal Durban have been drained and filled. The floristic composition of the diagnostic species group i.e. the *Phragmites australis* species group (Appendix .25), clearly illustrates the dominance of reeds within this community. The general floristic composition of Community 12 accords well with that provided by Ward (1980) for 'reedswamp communities'.

Community 12, like Community 11, represents a unique floristic unit. The majority of the floristic similarities demonstrated by Community 12 indicate similarities in disturbance regimes rather than fundamental ecological similarities. Community 12 is related to Community 13 through the shared presence of the *Verbena bonariensis** species group (Appendix .27). It is also related to the grasslands of Community 11 and Community 13 through the shared presence of the *Mariscus sumatrensis* species group (Appendix .28). The species composition of these differential groups indicates the nature of these floristic associations, as the majority of the species are ruderal and/or invasive species.

Community 12 is also related to the disturbed shrublands of Community 9 & 10, as well as Community 13 through the shared presence of the *Cynodon dactylon* species group (Appendix .29). Fifty per cent of the species within the *Cynodon dactylon* species group (Appendix .29) are alien and characteristic of badly disturbed areas,

e.g. the garden escapees *Ageratum conyzoides** and *Canna generalis**. This again indicates that these floristic similarities are largely due to common disturbance regimes rather than any fundamental ecological similarities between the community types. Many of the alien species in these shared species groups favour the moister conditions offered in the floodplain regions e.g. *Ageratum conyzoides**, *Canna generalis**, *Paspalum urvillei**, *Pennisetum purpureum** and *Senna didymobotrya**.

General connections are also indicated between Community 12 and Communities 5, 7, 9, 10 & 13 through the shared presence of the *Melia azedarach** species group (Appendix .30). Again the floristic relationship is a superficial one, indicating the shared presence of several generalist (and for the most part, alien) species which are widespread throughout the disturbed areas of the urban landscape and which proliferate under the disturbed conditions found in many of the floodplain and wetland areas. This is clearly indicative of a situation where *bona fide* floristic links may well have been obscured by the overriding effects of disturbance.

Both the average cover and percentage occurrence of *Chromolaena odorata** and *Lantana camara** in Community 12 are lower than those for Community 11 (Figures 5 & 6), with both species achieving only minimal representation within this community, despite the fact that many of these areas have been extensively disturbed in the past. This could be due to the damper conditions experienced in these areas. Diversity is on a par with Community 11 (Figure 4) and the D structure of the community (Figure 2L) is due to the predominance of reeds and grasses.

Community 13: *Senecio madagascariensis*–*Panicum maximum* Tall Closed Shrubland//Short Closed Grassland Mosaic (Figure 18)

This closed tall closed shrubland//short closed grassland community mosaic (Edwards 1983) is found at altitudes of 1–287 m. It is represented by 69 relevés (Appendix) with 2–44 species per relevé. This community has a D structure (Ito 1979; Figure 2M) with the greatest average cover in the 0.5–5.0 m height class of 72.4% which contains a high proportion of grass. The 0–0.5 m height class also contains significant levels of grass.

Habitat

The soils underlying this community are diverse and include the Arcadia Form, Rydalvale Series; Cartref Form, Cartref Series; Dundee Form, Dundee Series; Fernwood Form, Fernwood Series; Glenrosa Form, Williamson Series; Hutton Form, Clanshal Series; Katspruit Form, Katspruit Series; Kroonstad Form, Mkambati Series; Longlands Form, Waldene Series; Milkwood Form, Milkwood Series; Mispah Form, Mispah Series; Rensburg Form, Phoenix Series and several areas of landfill. The four most common are the Mispah Mispah soils (12 relevés), the Cartref Cartref soils (11 relevés), fill sites (10 relevés) and Dundee Dundee soils (9 relevés). The terrain occupied by this community varies from flat at some sites to an inclination of 39.8° at others, with all eight points of an eight-point compass rose represented. The most



FIGURE 18.—Community 13: *Senecio madagascariensis*–*Panicum maximum* Tall Closed Shrubland//Short Closed Grassland Mosaic. Most ubiquitous community, ranges from grassland through to a variety of shrub-invaded types. Species recorded: *Eragrostis curvula*, *Flaveria bidentis**, *Leucaena leucocephala**, *Panicum maximum*, *Rhynchelytrum repens* and *Senecio chrysocoma*. Location: Bay-head grassland.

common directions are east (20 relevés), north (14 relevés) south (11 relevés) and west (10 relevés). Climbers

Floristics

This community is defined by the *Senecio madagascariensis* species group (Appendix .26). The species diversity per unit area averages 0.15 species per m² for the 69 relevés, with an average of 17.0 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Lantana camara</i> * (shrub)	49.3%	14.9%
<i>Chromolaena odorata</i> * (shrub)	36.2%	9.6%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Panicum maximum</i> (grass)	52.2%	20.5%
<i>Eragrostis curvula</i> (grass)	49.3%	14.2%
<i>Sida rhombifolia</i> (forb)	43.5%	1.5%
<i>Senecio polyanthemoides</i> (forb)	37.7%	3.4%
<i>Cynodon dactylon</i> (grass)	33.3%	17.5%
<i>Rhynchelytrum repens</i> (grass)	33.3%	5.0%
<i>Physalis viscosa</i> * (forb)	31.9%	1.5%
<i>Commelina erecta</i> (forb)	29.0%	0.8%
<i>Tagetes minuta</i> * (forb)	24.6%	1.8%
<i>Sporobolus africanus</i> (grass)	23.2%	6.3%
<i>Sorghum bicolor</i> (grass)	23.2%	4.6%
<i>Bidens pilosa</i> * (forb)	23.2%	1.8%
<i>Conyza floribunda</i> * (forb)	20.3%	1.0%

The only climber present in more than 20% of relevés is:

<i>Hewittia sublobata</i> (forb)	24.6%	2.9%
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General

This community represents disturbed grassland areas, and is the most widespread community in the municipal area. The disturbed nature of the this community is clearly indicated by the fact that 44% of the diagnostic species in the *Senecio madagascariensis* species group (Appendix .26) are alien species. The grass species which dominate Community 13 are widely distributed species and are particularly common in disturbed areas (Tainton *et al.* 1976). The increased levels of cover and occurrence of perennial species such as *Cynodon dactylon* (Increaser II) and *Eragrostis curvula* (Increaser II) relative to Community 11 also indicate the poorer comparative quality of the sward, as these are usually predominant in highly disturbed areas. The widespread nature and relatively high average cover of the annual *Rhynchelytrum repens* (Increaser II), may also pose erosion problems because of inadequate soil protection (Tainton *et al.* 1976).

Community 13 is related to the wetlands i.e. Community 12 through the shared presence of the *Verbena bonariensis** species group (Appendix .27). These two communities in turn are related to Community 11 through the shared presence of the *Mariscus sumatrensis* species group (Appendix .28). Its broad relationship with Communities 9, 10 & 12 is indicated through the shared presence of the *Cynodon dactylon* species group (Appendix .29). Floristic associations with the dune communities (Community 3), coast forest (Community 5), valley bushveld (Community 7), disturbed shrublands (Communities 8, 9 & 10) and wetlands (Community 12) is indicated through the common presence of the *Melia*

*azedarach** species group (Appendix .30) and the *Setaria megaphylla* species group (Appendix .31). These species groups indicate the presence of widespread generalists (both alien and indigenous) such as *Ipomoea* sp. and *Cardiospermum grandiflorum**, which occur in all these communities as a result of disturbance throughout the urban landscape. The result is a blurring of floristic boundaries and, any 'true' distinctness which once might have existed, is now largely obscured.

Although Community 13 is clearly a product of disturbance, the average cover and percentage occurrence of *Chromolaena odorata** and *Lantana camara** are significantly lower than those found in communities such as 8, 9 & 10 (but higher than those found in Communities 11 & 12, Figures 5 & 6). *Lantana camara** has the highest average cover values and is the most widespread of the two species. It is probable that Community 13 thus represents areas where disturbed grasslands have been invaded by these two species (Ward 1980; Liggitt 1983). It is likely that without intervention the invasive shrub species already well represented in this community will continue to encroach further, eventually making Communities 9 & 13 indistinguishable.

Woody encroachment is also suggested by the presence of species such as *Dichrostachys cinerea*, *Dichrostachys cinerea* sapling, *Morus* sp.*, *Pseudarthria hookeri* sapling and *Rhus chirindensis* sapling, within the *Cynodon dactylon* species group (Appendix .29). Species such as *Dichrostachys cinerea* are well known invaders of open grassland (Ward 1980), and confirm the idea of an element of woody encroachment into the grassland areas found in Communities 9, 10, 11, 12 & 13. This is further supported by the presence of *Clerodendrum glabrum* sapling, *Melia azedarach** and *Melia azedarach** seedlings in the *Melia azedarach** species group (Appendix .30). *Melia azedarach** particularly is an important element in the early seral stages of woodland and forest communities in the Durban area (Ward 1980). The species diversity of

Community 13 is far higher than that for Community 12 (Figure 4) and can be attributed to the large number of alien species found within this community. The D structure (Figure 2M) is due to the predominance of shrub, grass and forb species.

Community 14: *Phyllanthus burchellii*-*Digitaria eriantha* Short Closed Grassland/Tall Sparse/Closed Shrubland Mosaic (Figures 19 & 20)

This short closed grassland/tall sparse/closed shrubland community mosaic (Edwards 1983) is found at altitudes of 35–170 m. It is represented by twenty relevés (Appendix) with 7–45 species per relevé. It has a D structure (Ito 1979; Figure 2N) with the greatest average cover of 86.0% in the 0.5–5.0 m height class. This group is made up predominantly of grasses. No vegetation cover in this community is above 5 m in height.

Habitat

The soils underlying this community are of the Cartref Form, Cartref Series; Glenrosa Form, Williamson Series; Hutton Form, Clansthal Series; Kroonstad Form, Avoca Series; Kroonstad Form, Mkambati Series; Mispah Form, Mispah Series; Rensburg Form, Phoenix Series and Swartland Form, Swartland Series. The most common are the Hutton Clansthal soils (5 relevés) and the Kroonstad Mkambati soils (4 relevés). The terrain occupied by this community varies from flat at some sites to an inclination of 22.6° at others. All eight points of an eight-point compass rose are represented, except northwest. An easterly direction is most common (6 relevés).

Floristics

This community is distinguished by the *Phyllanthus burchellii* species group (Appendix .32). The species diversity per unit area averages 0.21 species per m² for the community, with an average of 23.5 species per relevé.



FIGURE 19.—Community 14: *Phyllanthus burchellii*-*Digitaria eriantha* Short Closed Grassland/Tall Sparse/Closed Shrubland Mosaic. Wide variation in diversity of herb layer evident in these grasslands. Species-rich Treasure Beach Grasslands—*Acalypha petiolaris*, *Digitaria eriantha*, *Eugenia albanensis*, *Glycine wightii*, *Helichrysum decorum*, *Helichrysum kraussii*, *Helichrysum panduratum*, *Phyllanthus burchellii*, *Rumex sagittatus*, *Salacia kraussii* and *Thesium goetzeanum*. *Strelitzia nicholai* in background.



FIGURE 20.—Community 14: *Phyllanthus burchellii*–*Digitaria eriantha* Short Closed Grassland//Tall Sparse/Closed Shrubland Mosaic. Wide variation in diversity of herb layer evident in these grasslands. Depauperate grasslands of old Phoenix canal—*Bidens pilosa**, *Digitaria eriantha*, *Panicum maximum*, *Rhynchosytrum repens*, *Sesbania sesban* and *Tagetes minuta**, *Saccharum officinarum** in background indicates past cultivation of site.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Lantana camara</i> * (shrub)	60.0%	9.8%
<i>Chromolaena odorata</i> * (shrub)	35.0%	10.5%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Nidorella auriculata</i> (forb)	70.0%	2.9%
<i>Tagetes minuta</i> * (forb)	55.0%	2.2%
<i>Crotalaria lanceolata</i> (forb)	55.0%	0.5%
<i>Phyllanthus burchellii</i> (grass)	50.0%	1.2%
<i>Panicum maximum</i> (grass)	40.0%	24.8%
<i>Cassia mimosoides</i> (forb)	40.0%	8.0%
<i>Rhynchosytrum repens</i> (grass)	35.0%	6.1%
<i>Digitaria eriantha</i> (grass)	30.0%	16.6%
<i>Aristida junciformis</i> (grass)	30.0%	10.3%
<i>Eragrostis curvula</i> (grass)	30.0%	8.5%
<i>Helichrysum decorum</i> (forb)	30.0%	2.0%
<i>Bidens pilosa</i> * (forb)	30.0%	1.9%
<i>Hyparrhenia hirta</i> (grass)	30.0%	1.4%
<i>Senecio chrysocoma</i> (forb)	30.0%	0.7%
<i>Senecio polyanthemoides</i> (forb)	30.0%	0.07%
<i>Oxalis</i> sp.* (forb)	30.0%	0.05%
<i>Helichrysum longifolium</i> (forb)	25.0%	3.2%
<i>Eriosema parviflorum</i> (forb)	25.0%	3.0%
<i>Tephrosia macropoda</i> (forb)	25.0%	2.3%
<i>Helichrysum panduratum</i> (forb/shrub)	25.0%	0.4%
<i>Zornia capensis</i> (forb)	25.0%	0.3%
<i>Senecio</i> sp. (forb)	25.0%	0.07%
<i>Laggera alata</i> (forb)	25.0%	0.005%
<i>Sorghum bicolor</i> (grass)	20.0%	7.6%
<i>Sida rhombifolia</i> (forb)	20.0%	3.8%
<i>Sporobolus africanus</i> (grass)	20.0%	2.2%
<i>Cymbopogon validus</i> (grass)	20.0%	1.2%
<i>Centella asiatica</i> (forb)	20.0%	0.9%
<i>Asystasia gangetica</i> (forb)	20.0%	0.7%
<i>Commelina erecta</i> (forb)	20.0%	0.6%

<i>Desmodium incanum</i> (forb)	20.0%	0.1%
<i>Richardia brasiliensis</i> * (forb)	20.0%	0.06%
<i>Cheilanthes viridis</i> (fern)	20.0%	0.05%

Climbers

The only climber present in more than 20% of relevés is:

<i>Hewittia sublobata</i> (forb)	25.0%	10.0%
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Saplings and seedlings

Saplings and seedlings occurring in more than 20% of the relevés representing the community are:

<i>Melia azedarach</i> * sapling (tree)	25.0%	0.6%
<i>Albizia adianthifolia</i> sapling (tree)	20.0%	4.6%
<i>Tagetes minuta</i> * seedlings (forb)	20.0%	0.4%

General

Other than the recently burned grasslands represented by Community 16, where the herb diversity would be expected to be high, Community 14 has the highest forb diversity of all the grasslands identified in this study. It also has the second highest overall species diversity of all the communities surveyed. As is the case with Community 13, the diagnostic species group for this community, the *Phyllanthus burchellii* species group (Appendix .32), is dominated by forb species indicating that it is on the basis of the forb component rather than the grass sward that grasslands are distinguished. The better quality of the Community 14 grasslands, as compared to those included within Community 13, is highlighted by the fact that only 18.8% of the diagnostic species for Community 14 are alien, as compared to the 44.4% of Community 13.

As with Communities 11 & 13, *Panicum maximum* (Decreaser) and *Eragrostis curvula* (Increaser II) form a major component of the sward in Community 14. *Eragrostis curvula* in particular is indicative of disturbance

and badly managed areas. The occurrence and cover of *Rhynchelytrum repens* (Increaser II) is virtually identical to that found in Community 13 and could represent an erosion hazard in badly managed or impacted areas. *Aristida junciformis* (Increaser III), *Cymbopogon validus* (Increaser I) and *Digitaria eriantha* (Decreaser) appear for the first time as major grassland constituents. *Digitaria eriantha* is one of the most visible components of this grassland type, and together with the high cover values for *Panicum maximum*, another Decreaser species, indicates an improving sward quality. The presence of a wide range of grass types, i.e. Decreasers, Increaser I, Increaser II and Increaser III suggests that areas included within this community show a range of disturbance regimes ranging from under- to over-utilisation.

The presence of the pioneer species *Aristida junciformis* has important management implications because of the difficulty in eradicating it from the sward, and its tendency to dominate under conditions of disturbance. The presence of *Hyparrhenia hirta* also suggests a history of past disturbance, as this species usually predominates on 'old-land sites' (Tainton *et al.* 1976). The presence of *Saccharum officinarum** in the diagnostic species for Community 14 confirms that cultivation was an important source of disturbance. This observation is supported by the widespread occurrence of Community 14 in the old canelands of Phoenix.

This community shows an increase in the forb and grass component and a decrease in the shrub component when compared with Community 13. However, woody encroachment is an ever-present threat as indicated by the presence of *Lantana camara** seedlings in the *Conyza floribunda** species group (Appendix .33), which is shared by Communities 12, 13 & 14. This is further confirmed by the presence of *Chrysanthemoides monilifera* and *Melia azedarach** sapling in the *Tagetes minuta** species

group (Appendix .35), which is shared by Communities 3 and 5–13. *Albizia adianthifolia* saplings are also present within a fifth of the relevés defining Community 14. *Albizia adianthifolia* is noted by Ward (1980) as 'an invader of grassland, often dominant in woodland seral to forest'.

It is important to realise that while the overall herb diversity of this community is high, there is a gradient of diversity within the community itself. This ranges from the relatively depauperate old canefields of the Phoenix area, to the species-rich grasslands at Treasure Beach. This difference is probably best related to the timescale of disturbance and the level of active management that has been operative in these areas.

Community 14 shows strong floristic links with Community 13 and Community 12 (wetlands/floodplains) through the shared presence of the *Conyza floribunda** species group (Appendix .33). The species composition of this group indicates the presence of damp conditions in all of these communities through the shared presence of species such as *Andropogon eucomus*, *Cyperus distans*, *Cyperus sphaerospermus*, *Imperata cylindrica* and *Pycreus polystachyos*, which are characteristic of badly drained areas. It is related to Communities 10, 11 & 13 through the shared presence of the *Cassia mimosoides* species group (Appendix .34), which does not occur in the wetland areas and is more characteristic of open grassland areas. A broad association between Community 14 and the remainder of the communities so far described (except for Communities 1, 2 & 4) is demonstrated by the shared presence of the *Tagetes minuta** species group (Appendix .35). The fact that the species in this group are predominantly indigenous indicates a common floristic link extending throughout the herb layer of the urban landscape. Most of these species are generalists, and are common in disturbed areas, but this commonality does



FIGURE 21.—Community 15: *Sutera kraussiana*–*Aristida junciformis* Low/Short Closed Grassland. Note sward dominated by *Aristida junciformis*. Other species recorded: *Cassia mimosoides*, *Crotalaria lanceolata*, *Desmodium incanum*, *Helichrysum* sp., *Indigofera hiliaris*, *Rhynchelytrum repens*, *Sporobolus africanus* and *Teramnus labialis*. Location: Welbedacht.

reinforce the concept of landscape- as opposed to community-based conservation.

The average cover for *Lantana camara** in Community 14 is lower than the equivalent levels found in Community 13, but demonstrates a higher percentage occurrence. The reverse situation exists for *Chromolaena odorata** (Figures 5 & 6). Community 14 has the highest percentage occurrence of *Lantana camara** of all the grasslands, suggesting that this shrub may pose a potentially severe encroachment problem in this community. Because of the extensive herb complement within this community, Community 14 has the highest species diversity of any community (other than the recently burned grasslands of Community 16, Figure 4). The lack of cover in the >5 m height class and the D structure of the community (Figure 2N) is due to the predominance of forb and grass species in this community.

Community 15: *Sutera kraussiana*–*Aristida junciformis* Low/Short Closed Grassland (Figure 21)

This low/short closed grassland community (Edwards 1983) is found at altitudes of 5–332 m. It is represented by 18 relevés (Appendix) with 7–34 species per relevé. This community has a D structure (Ito 1979; Figure 2O) with the greatest average cover of 52.7% in the 0.5–5.0 m height class. This is a more open grassland community than Community 14.

Habitat

The soils underlying this community include the Cartref Form, Cartref Series; Fernwood Form, Fernwood Series; Glenrosa Form, Williamson Series; Hutton Form, Clansthal Series; Katspruit Form, Katspruit Series; Kroonstad Form, Avoca Series; Longlands Form, Waldene Series; Milkwood Form, Milkwood Series and Mispah Form, Mispah Series. The Mispah Mispah soils are the most common occurring in 7 out of 18 relevés. The terrain occupied by this community varies from flat at some sites to an inclination of 26.6° at others, in an east, southeast, south, west, and northwest direction. Of these, east and south are the most common occurring in 5 relevés each.

Floristics

This community is distinguished by the *Oxalis latifolia** species group (Appendix .36). The species diversity averages 0.13 species per m² for the community with an average of 14.8 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Lantana camara</i> * (shrub)	38.9%	5.3%
<i>Chromolaena odorata</i> * (shrub)	3.3%	14.9%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Nidorella auriculata</i> (forb)	66.7%	3.6%
<i>Eragrostis curvula</i> (grass)	50.0%	19.4%
<i>Hyparrhenia hirta</i> (grass)	33.3%	12.5%
<i>Teramnus labialis</i> (forb)	33.3%	0.4%
<i>Aristida junciformis</i> (grass)	27.8%	13.7%
<i>Senecio variabilis</i> (forb)	27.8%	7.5%
<i>Vernonia capensis</i> (forb)	27.8%	4.2%
<i>Centella asiatica</i> (forb)	27.8%	0.02%
<i>Sporobolus africanus</i> (grass)	22.2%	7.3%
<i>Senecio polyanthemoides</i> (forb)	22.2%	1.3%
<i>Hypoxis rooperi</i> (geophyte)	22.2%	1.3%
<i>Digitaria</i> sp. (grass)	22.2%	1.0%
<i>Sonchus wilmsii</i> (forb)	22.2%	0.06%

General

Community 15 demonstrates a limited association with Community 14 through the common presence of the *Lo-belvia erinus* species group (Appendix .37). A more significant association with the two grassland Communities 13 & 14, is indicated by the common presence of the *Digitaria eriantha* species group (Appendix .38). This suggests the existence of a range of indigenous grasses and forbs common to these three major grassland types in the urban area, and reinforces the need for ecological continuity between communities. A broad association with all of the previously discussed communities except the mangroves (Community 1) is indicated by the common presence of the *Senecio polyanthemoides* species group (Appendix .39).

This group is dominated by generalists, opportunists, invasive and pioneer species and serves to re-emphasise the fact that disturbance throughout the municipal landscape has blurred the original floristic boundaries by providing conditions ideally suited to the proliferation of these r-selected species. The problem of woody encroachment into the grassland areas is again highlighted through the presence of *Albizia adianthifolia*, *Chromolaena odorata** and *Psidium guajava** in the *Senecio polyanthemoides* species group (Appendix .39).

An important characteristic of Community 15 is the marked drop in species diversity as compared to Community 14 (Figure 4). This is the result of a decrease in the diversity of the forb layer. This is also accompanied by a decrease in the diversity of the grass sward and an increase in the cover of grass species such as *Aristida junciformis* (Increaser III), *Eragrostis curvula* (Increaser II) and *Hyparrhenia hirta* (Increaser II) (all relative to Community 14). These species (particularly the predominance of *Aristida junciformis* in many areas) suggest previous mismanagement and disturbance through overgrazing and poor agricultural practices (Tainton 1981b). Of all the grassland communities sampled, Community 15 has the highest cover values for *Aristida junciformis*, and the second highest cover values for *Eragrostis curvula* and *Sporobolus africanus*.

Further confirmation of disturbance is provided by the significant presence of the two invasive shrub species *Chromolaena odorata** and *Lantana camara**. Relative to Community 14 the average cover of *Chromolaena*



FIGURE 22.—Community 16: *Hypoxis gerrardii*–*Alloteropsis semialata* Low Closed Grassland. Species recorded include: *Berkheya speciosa*, *Cyperus obtusiflorus*, *Helichrysum* sp. and *Hypoxis* sp. Location: Silverglen Nature Reserve.

*odorata** increases and that of *Lantana camara** decreases (Figure 5) The percentage occurrence of both species decreases (Figure 6). The D structure of this community (Figure 20) is due to the predominance of grass species.

Community 16: *Hypoxis gerrardii*–*Alloteropsis semialata* Low Closed Grassland (Figure 22)

This low closed grassland community (Edwards 1983) is found at altitudes of 128–157 m. It is represented by two relevés (Appendix) with 19–39 species per relevé. This community has a L structure (Ito 1979; Figure 2P) with the greatest average cover of 76.0% in the 0–0.5 m height class. There is no representation in the upper height classes of 0.5–5.0 m and greater than 5 m.

Habitat

The soils are of the Cartref Form, Cartref Series, and are derived from Natal Group Sandstone. The terrain slopes from 10.9° to 15.5° in a southerly direction.

Floristics

This community is distinguished by the *Alepidea* sp. species group (Appendix .40). The species diversity per unit area is 0.26 species per m² for the two relevés, with an average of 29.0 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Lantana camara</i> * (shrub)	0.0%	0.0%
<i>Chromolaena odorata</i> * (shrub)	0.0%	0.0%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

Diagnostic

<i>Alloteropsis semialata</i> (grass)	100.0%	34.0%
<i>Becium obovatum</i> (forb)	100.0%	20.0%
<i>Gerbera ambigua</i> (forb)	100.0%	18.5%
<i>Berkheya speciosa</i> (forb)	100.0%	8.5%
<i>Tristachya leucotrix</i> (grass)	100.0%	6.0%
<i>Aster bakeranus</i> (forb)	100.0%	6.0%
<i>Euphorbia natalensis</i> (forb)	100.0%	3.1%
<i>Alepidea</i> sp. (forb)	100.0%	3.1%
<i>Hypoxis gerrardii</i> (geophyte)	100.0%	3.0%
<i>Hypoxis acuminata</i> (geophyte)	100.0%	0.05%
<i>Rhynchelytrum repens</i> (grass)	50.0%	17.0%
<i>Aristida junciformis</i> (grass)	50.0%	5.5%
<i>Helichrysum cephaloideum</i> (forb)	50.0%	3.0%
<i>Scabiosa columbaria</i> (forb)	50.0%	3.0%
<i>Setaria sphacelata</i> (grass)	50.0%	3.0%
<i>Nidorella auriculata</i> (forb)	50.0%	0.5%
<i>Vernonia capensis</i> (forb)	50.0%	0.5%
<i>Cyperus obtusiflorus</i> (sedge)	50.0%	0.5%
<i>Thunbergia atriplicifolia</i> (forb)	50.0%	0.05%
<i>Tephrosia macropoda</i> (forb)	50.0%	0.05%

Non-diagnostic

<i>Digitaria setifolia</i> (grass)	50.0%	25.5%
<i>Senecio glaberrimus</i> (forb)	100.0%	18.5%
<i>Eulalia villosa</i> (grass)	50.0%	3.0%
<i>Pentanisia prunelloides</i> (forb)	50.0%	3.0%
<i>Urelytrum agropyroides</i> (grass)	50.0%	3.0%
<i>Helichrysum miconiifolium</i> (forb)	50.0%	3.0%
<i>Helichrysum griseum</i> (forb)	50.0%	0.5%
<i>Euryps</i> sp. (shrub)	50.0%	0.5%
<i>Cyanotis speciosa</i> (forb)	50.0%	0.05%
<i>Clusia cordata</i> (shrub)	50.0%	0.05%
<i>Andropogon appendiculatus</i> (grass)	50.0%	0.05%
<i>Sporobolus mauritanicus</i> (grass)	50.0%	0.05%
<i>Vernonia hirsuta</i> (forb)	50.0%	0.05%
<i>Watsonia densiflora</i> (geophyte)	50.0%	0.05%

General

The number of herb species in this community is very high compared to the levels exhibited by the other grassland communities identified in the study. This is linked to the fact that this community is defined by only two relevés and represents newly burned grassland areas. The occurrence of geophytes such as *Hypoxis gerrardii* within the diagnostic species is evidence of this latter fact. It is proposed that Community 16 represents the burned form of Community 17. This is suggested by the strong floristic similarity between these two communities indicated by the *Helichrysum cephaloideum* species group (Appendix .42), and the fact that Community 17 predominates in Silverglen Nature Reserve, the area in which the two relevés defining this community were sampled.

Community 16 is related to grassland Communities 13, 14, 15 & 17 through the shared presence of the *Helichrysum cephaloideum* species group (Appendix .42). The presence of *Themeda triandra* in this group would seem to indicate that this floristic similarity may be the result of these communities representing various levels of disturbance (and recovery?) of the original *Themeda triandra* sward which predominated prior to the advent of agriculture and urbanisation (Moll 1976). The association between Community 13 and Communities 14–17 at this level is slight, probably indicating a far greater level and/or frequency of disturbance in Community 13.

Of all the communities, 16 has the highest overall species diversity (due to the presence of an extensive forb component) (Figure 4), which points to the importance of fire as a management tool in maintaining the quality of grassland areas (Figures 5 & 6). The lack of woody species, especially *Chromolaena odorata** and *Lantana camara**, also indicates the value of fire in maintaining grassland areas and reducing the threat of woody encroachment.

In terms of sward composition the occurrence and comparatively high cover of *Rhynchelytrum repens* (Increaser II) could represent an erosion hazard in badly managed or impacted areas. The presence of the pioneer species *Aristida junciformis* (Increaser III) also has important management implications because of the difficulty in eradicating it from the sward and its tendency to dominate under conditions of disturbance. The presence of species such as *Allotriopsis semialata* (Increaser I), *Eulalia villosa* (Increaser I) and *Tristachya leucothrix* identified by Tainton & Mentis (1984) as a post-fire climax species are significant, as they indicate that these grasslands have been under-utilised, resulting in accumulation of dry material and the grassland becoming moribund. The L structure of this community (Figure 2P) can be attributed to the recent burn in these areas.

Community 17: *Helichrysum aureum*–*Themeda triandra* Short Closed Grassland (Figure 23)

This short closed grassland community (Edwards 1983) is found at altitudes of 83–133 m. It is represented by seven relevés (Appendix) with 7–31 species per relevé. This community has a D structure (Ito 1979; Figure 2Q) with the greatest average cover of 75.0% in the 0.5–5.0 m height class. This is composed predominantly of grass.

Habitat

The soils are mainly of the Cartref Form, Cartref Series (4 out of 7 relevés). Also present are soils of the Hutton Form, Clansthal Series; Milkwood Form, Milkwood Series and Mispah Form, Mispah Series. The terrain occupied by this community slopes from 7.5°–32.0°, in an northeastern, southeastern, southern and northern direction. Of these north is the most common aspect occurring in 4 out of 7 relevés.



FIGURE 23.—Community 17: *Helichrysum aureum*–*Themeda triandra* Short Closed Grassland. Species recorded: *Digitaria* sp., *Helichrysum auriceps*, *Setaria sphacelata* and *Themeda triandra*. Location: Stainbank Nature Reserve.



FIGURE 24.—Community 18: *Dianthus zeyheri*-*Eragrostis curvula* Short/Low Closed Grassland. Species recorded: *Cymbopogon excavatus*, *Desmodium incanum*, *Eragrostis curvula*, *Hyparrhenia hirta*, *Rhynchelytrum repens*, *Scabiosa columbaria*, *Setaria sphacelata*, *Sporobolus africanus* and *Xysmalobium undulatum*. Location: Newlands.

Floristics

This community is distinguished by the *Helichrysium aureum* species group (Appendix .41). The species diversity per unit area is 0.16 species per m² for the community, with an average of 17.9 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Lantana camara</i> * (shrub)	0.0%	0.0%
<i>Chromolaena odorata</i> * (shrub)	0.0%	0.0%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

<i>Teramnus labialis</i> (forb)	57.1%	0.3%
<i>Aristida junciformis</i> (grass)	42.9%	1.0%
<i>Aeschynomene micrantha</i> (forb)	42.9%	0.01%
<i>Chaetacanthus burchellii</i> (shrublet)	42.9%	0.01%
<i>Themeda triandra</i> (grass)	28.6%	23.9%
<i>Tephrosia macropoda</i> (forb)	28.6%	15.9%
<i>Setaria sphacelata</i> (grass)	28.6%	8.9%
<i>Monocymbium ceresiiforme</i> (grass)	28.6%	3.7%
<i>Panicum maximum</i> (grass)	28.6%	2.4%
<i>Cyperus obtusiflorus</i> (sedge)	28.6%	1.7%
<i>Selago woodii</i> (shrublet)	28.6%	1.7%
<i>Cymbopogon validus</i> (grass)	28.6%	1.6%
<i>Desmodium incanum</i> (forb)	28.6%	0.9%
<i>Helichrysium aureum</i> (forb)	28.6%	0.2%
<i>Xysmalobium undulatum</i> (forb)	28.6%	0.2%
<i>Gerbera piloselloides</i> (forb)	28.6%	0.1%
<i>Tephrosia kraussiana</i> (forb)	28.6%	0.1%
<i>Helichrysium cephaloideum</i> (forb)	28.6%	0.03%
<i>Eragrostis capensis</i> (grass)	28.6%	0.01%

General

This community is related to the other grassland Communities 13, 14, 15 & 16 through the common presence of the *Helichrysium cephaloideum* species group (Appendix .42). This is the same floristic association shown by Community 16, and supports the suggestion that these communities represent the burned and unburned version of the same or very similar communities. *Chromolaena odorata** and *Lantana camara** are also totally lacking from this grassland community (Figures 5 & 6), a reflection of the comparatively undisturbed nature of this community and the effect of active management (burning and clearing of alien invasives) in areas such as Silverglen Nature Reserve and Stainbank Nature Reserve where this community occurs.

The presence of *Themeda triandra* (Decreaser) within the differential species of this community indicates that it still bears some association with the primary grassland types i.e. the fire maintained *Themeda triandra* grassland proposed by Moll (1976). The species composition of Community 17 is virtually identical to that described as the 'Secondary *Aristida junciformis* understorey' of Moll's (1976) *Acacia sieberiana* Wooded Grassland.

The widespread presence of *Aristida junciformis* (Increaser III) in the sward is cause for concern and should be addressed as part of any management plan for this community. The presence of *Themeda triandra* (Decreaser), however, indicates the potential of the area to be returned to a high quality grassland. This is supported by the presence of another Decreaser species *Monocymbium ceresiiforme*. The idea that these grasslands may have been moribund for extended periods of time as indicated by the species composition of Community 16 is here also suggested by the presence of species such as *Helichrysium aureum*, which is diagnostic for this community. *Helichrysium aureum* is a fire-sensitive species which is a common weed in unburned or moribund fire-climax grasslands

(Tainton 1981c). The presence of Increaser I species such as *Cymbopogon validus* tends to confirm this.

As with Community 16, the relatively minor occurrence of species characteristic of the broad generalist *Chaetacanthus burchellii* species group (Appendix 45), indicates a less disturbed form of grassland than represented by Communities 14 & 15. The occurrence of *Aristida junciformis* in the sward, however, prescribes the need for management policies aimed at reducing the *Aristida* component and improving the *Themeda*.

In Community 17 there is a substantial decrease in species diversity to levels just higher than those recorded for the most heavily impacted grasslands (Communities 13 & 15) (Figure 4). The decrease in species diversity from the levels attained by Community 16, indicates that as the grass sward of this community type becomes moribund, so the forb diversity decreases. Thus, fire will obviously be an important management tool in maintaining the diversity of the herb populations in these grassland communities. The D structure of this community (Figure 2Q) is due to the predominance of grass and forb species.

Community 18: *Dianthus zeyheri*–*Eragrostis curvula* Short/Low Closed Grassland (Figure 24)

This short/low closed grassland community (Edwards 1983) is found at altitudes of 5–152 m. It is represented by 13 relevés (Appendix) with 2–43 species per relevé. This community (Edwards 1983) has a D structure (Ito 1979; Figure 2R) with the greatest average cover of 56.5% in the 0.5–5.0 m height class. No vegetation above 5 m occurs in this community type.

Habitat

The soils are mainly of the Mispah Form, Mispah Series (7 out of 13 relevés). Others underlying this community type include the Cartref Form, Cartref Series; Dundee Form, Dundee Series; Glenrosa Form, Williamson Series and Milkwood Form, Milkwood Series. The terrain occupied by this community varies from flat at some sites to an inclination of 39.8° at others, in a general easterly direction (8 relevés). Southeastern, southern and northern aspects are also noted.

Floristics

This community is distinguished by the *Dianthus zeyheri* species group (Appendix 43). The species diversity per unit area averages 0.17 species per m² for the 13 relevés, with an average of 19.0 species per relevé.

Trees and shrubs

Percentage occurrence and average cover of *Chromolaena odorata** and *Lantana camara** are:

<i>Lantana camara</i> * (shrub)	15.4%	7.1%
<i>Chromolaena odorata</i> * (shrub)	0.0%	0.0%

There are no conspicuous woody species with more than 5% mean cover and occurring in more than 20% of the relevés representing the community.

Herbs

Herb species occurring in more than 20% of the relevés representing the community are:

Diagnostic

<i>Eragrostis curvula</i> (grass)	76.9%	27.9%
<i>Chaetacanthus burchellii</i> (shrublet)	69.2%	1.0%
<i>Desmodium incanum</i> (forb)	61.5%	1.0%
<i>Stachys natalensis</i> (forb)	53.9%	2.3%
<i>Ruellia cordata</i> (undershrub)	46.2%	0.6%
<i>Teramnus labialis</i> (forb)	46.2%	7.9%
<i>Hyparrhenia hirta</i> (grass)	38.5%	25.8%
<i>Cymbopogon</i> sp. (grass)	38.5%	7.7%
<i>Gerbera ambigua</i> (forb)	38.5%	2.0%
<i>Hypoxis rooperi</i> (geophyte)	38.5%	0.6%
<i>Commelina africana</i> (forb)	38.5%	0.02%
<i>Setaria sphacelata</i> (grass)	30.8%	4.4%
<i>Indigofera hirsuta</i> (forb)	30.8%	2.0%
<i>Scabiosa columbaria</i> (forb)	30.8%	1.8%
<i>Aspilia natalensis</i> (forb)	30.8%	1.0%
<i>Vernonia capensis</i> (forb)	30.8%	0.5%
<i>Crabbea lirsuta</i> (shrublet)	30.8%	0.5%
<i>Cassia plumosa</i> (forb)	30.8%	0.02%
<i>Sonchus wilmsii</i> (forb)	30.8%	0.02%
<i>Gerbera piloselloides</i> (forb)	30.8%	0.008%
<i>Panicum maximum</i> (grass)	23.1%	12.2%
<i>Rhynchelytrum repens</i> (grass)	23.1%	2.6%
<i>Dianthus zeyheri</i> (forb)	23.1%	1.3%
<i>Thesium pallidum</i> (forb)	23.1%	0.9%
<i>Aeschynomene micrantha</i> (forb)	23.1%	0.09%
<i>Sida rhombifolia</i> (forb)	23.1%	0.09%
<i>Acalypha peduncularis</i> (forb)	23.1%	0.08%
<i>Xysmalobium undulatum</i> (forb)	23.1%	0.008%

Non-diagnostic

<i>Abrus precatorius</i> (undershrub)	23.1%	0.008%
<i>Senecio glaberimus</i> (forb)	23.1%	0.6%

General

This community is related to grassland Communities 14, 15, 16 & 17 through the common presence of the *Hypoxis acuminata* species group (Appendix 44). It is, however, distinct from these communities in that it shows no floristic association with Community 13, except at the grossest floristic level through the *Chaetacanthus burchellii* species group (Appendix 45). Communities 14–17 show distinct floristic links with the more disturbed Community 13 through groups such as the *Helichrysum cephaloideum* species group (Appendix 42). This species group does not include Community 18.

The predominant grass species in Community 18 are *Cymbopogon* sp. (Increaser I), *Eragrostis curvula* (Increaser II), *Hyparrhenia hirta* (Increaser II) and *Panicum maximum* (Decreaser). *Eragrostis curvula* is characteristic of 'disturbed areas' and 'badly managed veld' (Tainton et al. 1976). Similarly, the presence of *Hyparrhenia hirta* is probably due to the fact that Newlands (where the most extensive areas of this community occur) was previously used for the cultivation of sugarcane. *Hyparrhenia hirta* tends to 'become dominant on old-land sites' (Tainton et al. 1976). This grassland has a well-developed forb component, not found in badly impacted grasslands such as Community 15.

Woody encroachment into the grassland communities is clearly evident through the presence of *Acacia nilotica*,

Albizia adianthifolia sapling, *Chromolaena odorata** seedlings, *Lantana camara** and *Psidium guajava** sapling in the *Chaetacanthus burchellii* species group (Appendix 45), all of which occur in Community 18. It is probable that reduced fire frequency has played a role in facilitating this encroachment (Moll 1976).

As mentioned previously, Community 18 grasslands are largely restricted to the Newlands area of municipal Durban. This is one of the most obvious areas where the current classification is incompatible with Moll's (1976) assertion that the dominant grasslands in Durban are Secondary *Aristida junciformis* grasslands. Community 18 grasslands differ substantially on floristic grounds from Moll's (1976) secondary grasslands. The most noticeable difference is the absence of *Aristida junciformis*, which Moll (1976) regards as the 'dominant understorey grass', and the occurrence of *Panicum maximum* as a significant component of the sward.

Although the two invasive shrub species *Chromolaena odorata** and *Lantana camara** are present in Communities 13, 14 & 15, their significance decreases in Communities 16–18. This suggests that one is possibly dealing with a mosaic of disturbance and recovery patterns within the grassland community spectrum. Although clearly related to Communities 14–17 it is possible that Community 18 represents a transition to another grassland type not sampled during this survey, and which forms part of the community continuum that extends outside the municipal boundaries. Further research is needed to clarify the relationship of Community 18 to the other grassland communities in the urban area.

This grassland community has a higher species diversity than the Community 17 grasslands (Figure 4) and shows signs of prior disturbance through the presence of *Lantana camara**, although *Chromolaena odorata** is absent (Figure 5). *Lantana camara** has a greater percentage occurrence throughout all the grassland communities than *Chromolaena odorata** (Figure 6), suggesting that it may be a preliminary invader of these communities (Ward 1980). The control of this species should therefore be treated as a priority before it becomes a serious problem in the remaining grassland areas. Community 18, as with the remainder of the grassland communities, has a D structure (Figure 2R) due to the predominance of grass and forb species.

DISCUSSION AND CONCLUSIONS

The classification of vegetation in the municipal Durban area demonstrated the existence of 18 identifiable floristic communities, eight of which had not been previously described. Research into the long-term dynamics of all 18 communities will form part of Durban's ongoing open space planning and management initiative.

In comparison to previous vegetation surveys which have included the Durban municipal area or the majority thereof, i.e. Acocks (1988), Cawood (1980) and Moll (1976), this study presents a marked refinement in community description and identification. This has obvious advantages from a urban planning point of view, if the aim is the establishment of an ecologically viable open space system. According to Acocks's (1988) community descrip-

tions, four main vegetation types could be identified within the municipal area: Typical Coast-belt Forest, Dune Forest, Mangrove Forest and Northern Variation of the Valley Bushveld. However, the associated mapping contribution by Acocks's (1988), at a scale of 1:1 500 000, prevented representation of this detail, and the whole city is merely located within a belt of Coastal Forest and Thornveld.

Moll (1976) in his *The Three Rivers region: a vegetation study* also identified four community types within the municipal area: Coast Forest and Palm Veld, Dry Valley Scrub and Woodland Mosaic, *Acacia sieberiana* Savanna and Mangrove Swamp, with an associated mapping contribution of 1:250 000. Although Moll (1976) shows a more detailed rationalisation of the community distribution, there are some discrepancies between the communities represented on the 1:250 000 map and the communities which actually existed on the ground. By tracing the municipal boundary on to Moll's (1976) vegetation map it is possible to ascertain that according to the map, Phoenix is occupied by Coast Forest and Palm Veld. This may well represent the natural potential for the area, but at present the area is occupied by grasslands (e.g. Community 14) which have developed following the clearing of extensive canelands which existed even when Moll mapped Phoenix. This draws attention to the critical fact that both Acocks and Moll tended to map the natural communities which would have occurred at particular sites, or their nearest equivalents, rather than ground truthing these areas.

Of the three studies, Cawood (1980) presents the most detailed analysis of community types within the municipal area. He identified seven distinct groupings: Coast Forest/Scrub and Woodland Mosaic, Dune Forest, Mangrove Swamp, Bush Clump and Grassland Mosaic, Timber Plantation, Heavily Disturbed and Intergradation of Coast Forest/Scrub and Woodland Mosaic and Bush Clump and Grassland Mosaic. The mapping contribution of this study was presented at a scale of 1:50 000, and of the three represents the most detailed and accurate description of plant community distribution and location in the Durban area. But not all of municipal Durban is included within Cawood's Greater Durban boundaries, as the section north of the Umgeni River is omitted. Its usefulness to planners in municipal Durban is further reduced by the fact that many of the smaller open areas were not mapped or surveyed.

Moll (1976) recognised the limitations of these three studies when he wrote, 'plant studies can play an important role in planning for future development. However, at the scale at which the present survey was conducted, only broad guidelines can be given for the region; the planning of specific local areas requires more detailed plant ecological studies.' The aim of the present study was therefore to address this shortfall and to present a more detailed community analysis and associated mapping contribution (1:6 000) for municipal Durban; one that is sufficiently accurate in terms of floristic detail and actual community distribution to provide an effective planning and management tool. It also highlighted the need for a more encompassing and holistic view of urban conservation. Extensive floristic links in the Durban area indicate the need for a

landscape- (rather than a species- or even community-) based approach to open space design (Forman & Godron 1986). This in turn implies that the ecological viability of any open space system proposed for the City can only be ensured through the mitigation of landscape fragmentation, e.g. through the provision of dispersal corridors and the implementation of management techniques favouring naturalisation and the recreation of natural habitat settings. These guidelines have been employed in the design of the municipal Durban open space system described by Roberts (1990).

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APPENDIX

Synoptic table showing the general species characteristics of each of the 52 communities distinguished in the study area. Complete phytosociological tables for both the diagnostic species and the non-diagnostic species are available from the author or Dr R.H. Westfall, Agricultural Research Council, Rooideplaat Grassland Institute, Private Bag X05, Lynn East 0039, Pretoria.

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table)

Community number	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
1. <i>Avicennia marina</i> - <i>Bruguiera gymnorhiza</i> mangrove short forest																		
<i>Avicennia marina</i> (T) **					5													
<i>Bruguiera gymnorhiza</i> (T)					5													
<i>Rhizophora mucronata</i> (T)					3													
<i>Avicennia marina</i> seedlings (T)					2													
<i>Bruguiera gymnorhiza</i> seedlings (T)					2													
<i>Rhizophora mucronata</i> seedlings (T)					2													
2. <i>Mimusops caffra</i> - <i>Allophylus natalensis</i> low/short thicket																		
<i>Mimusops caffra</i> (T)					+ 2		+											
<i>Allophylus natalensis</i> (T)					+ 2													
<i>Cynanchum obtusifolium</i> (CL)					2													
<i>Mimusops caffra</i> sapling (T)					+ 2		+											
<i>Cordia caffra</i> sapling (T)					1		+											
<i>Croton sylvaticus</i> (T)					+ +								+					
<i>Deinbollia oblongifolia</i> seedlings (T)					+ +		+											
<i>Drypetes natalensis</i> (T)					+ +		+											
<i>Ficus lutea</i> (T)					1				+									
<i>Carissa bispinosa</i> sapling (S)					1													
<i>Cordia caffra</i> seedling (T)					1													
<i>Cyphostemma flaviflorum</i> (F/C)					1													
<i>Pavetta revoluta</i> sapling (S)					1													
<i>Tricalysia sonderiana</i> (S/T)					1													
<i>Bequaertiodendron natalense</i> (T)						5												
<i>Rawsonia lucida</i> sapling (T)						3												
<i>Teclea natalensis</i> sapling (T)						2												
3. Differential species for communities 2 & 3																		
<i>Eugenia capensis</i> (S)					3 +		+										+	
<i>Abutilon sonneratianum</i> (F)					+ 1												+	
<i>Barleria obtusa</i> (SL)					+ 1													+
4. <i>Manilkara discolor</i> - <i>Tricalysia lanceolata</i> short thicket																		
<i>Manilkara discolor</i> sapling (T)					4													
<i>Manilkara discolor</i> (T)					4													
5. Differential species for communities 3 & 4																		
<i>Tricalysia lanceolata</i> (S/T)					2 3		+	+										
<i>Drypetes arguta</i> sapling (T)					+ 3		+											
<i>Vernonia angulifolia</i> (F)					1		+										+	

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (CL) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX — Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
6. <i>Protorhus longifolia</i> (sapling) - <i>Psychotria capensis</i> short thicket																		
<i>Canthium obovatum</i> sapling (T)						1					+							
<i>Protorhus longifolia</i> sapling (T)						1												
<i>Xylothea kraussiana</i> sapling (S)						1												
<i>Capparis brassii</i> (CL)						1												
<i>Capparis sepiaria</i> (CL)						1	+											
<i>Chaetacme aristata</i> sapling (T)						1						+						
<i>Cola natalensis</i> sapling (T)			+			1												
<i>Ekebergia capensis</i> sapling (T)						1												
<i>Entada spicata</i> seedlings (S/C)			+			1												
<i>Maytenus peduncularis</i> sapling (F)						1				+								
<i>Mimusops obovata</i> sapling (T)			+			1												
<i>Mimusops obovata</i> (T)						1												
<i>Celtis africana</i> sapling (T)						1												
<i>Cyphostemma hypoleucum</i> seedlings (F/C)						1												
<i>Hibiscus tiliaceus</i> (T)						1												
<i>Momordica</i> sp. seedlings (F/C)						1												
<i>Teclea gerrardii</i> (T)						1												
<i>Vepris lanceolata</i> sapling (T/S)						1												
<i>Vepris lanceolata</i> (T/S)						1												
7. Differential species for communities 4 & 5																		
<i>Psychotria capensis</i> (S/T)			+			3	3				+							
<i>Canthium inerme</i> (T)			+			3	1											
<i>Canthium obovatum</i> (T)						+	1			+	+							
<i>Protorhus longifolia</i> (T)						+	1			+								
<i>Tricalysia lanceolata</i> sapling (S/T)						+	3	1										
<i>Cussonia</i> sp. (T)						+	1	+										
8. Differential species for communities 3, 4 & 5																		
<i>Rhoicissus rhomboidea</i> (S/C)			+			2	+	+	1		+	+						
<i>Deinbollia oblongifolia</i> sapling (T)						3	+		1		+	+						
<i>Flagellaria guineensis</i> (CL)						1	2		2	+		+						
<i>Deinbollia oblongifolia</i> (T)						1	+		2	+								
<i>Carissa bispinosa</i> (S)						1	2	+	1			+						
<i>Tinospora caffra</i> (CL)			+			2			1									
<i>Cordia caffra</i> (T)						2			1									
<i>Drimyopsis maculata</i> (GEO)						1	+		1			+					+	
<i>Psychotria capensis</i> sapling (S/T)						1	+		+	1								
<i>Pyrenacantha scandens</i> (CL)						1			1		+							
<i>Strelitzia nicolai</i> (T)						1	+		1		+	+					+	
<i>Drypetes arguta</i> (T)							3		1	+								
<i>Digitaria diversinervis</i> (G)			+	+		+			1								+	
<i>Drypetes natalensis</i> sapling (T)						1	+		1									
<i>Panicum laticomum</i> (G)						1		+	+		+	+						
<i>Protasparagus falcatus</i> (CL)							+	3	+		+	+						
<i>Bequaertiodendron natalense</i> sapling (T)							3		1									
<i>Momordica involucreta</i> (F/C)						1		+									+	
<i>Secamone alpinii</i> (CL)						1			+		+							
<i>Strychnos madagascariensis</i> (T)							+		1	+								
<i>Celosia trigyna</i> (F)						1		+				+						
<i>Maerua racemulosa</i> (S)							+		1	+								
<i>Xylothea kraussiana</i> (S)							2		1									

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (CL) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
9. Differential species for communities 2, 3 & 5																		
<i>Ficus burtt-dayi</i> (S)					2	2		1										
<i>Rhus nebulosa</i> (S)					2	+		1	+								+	
<i>Canthium</i> sp. sapling (T)					+	+		1		+								
<i>Maytenus procumbens</i> (S)					3			1										
10. <i>Rhus pentheri</i> - <i>Cussonia spicata</i> low thicket																		
<i>Rhus pentheri</i> (T)						+	2			+							+	
<i>Cussonia spicata</i> (T)							2	+										
<i>Dombeya tiliacea</i> (T)							2	+										
<i>Acacia robusta</i> (T)							1										+	
<i>Protaspargus densiflorus</i> (CL)						+	1											
<i>Abutilon</i> sp. (F)							1	+										
<i>Acalypha glabrata</i> sapling (T)							1	+										
<i>Acalypha sonderiana</i> sapling (T)						+	1											
<i>Capparis fascicularis</i> (CL)							+	1										
<i>Combretum kraussii</i> (T)					+		1											
<i>Commiphora harveyi</i> (T)							+	1										
<i>Euphorbia triangularis</i> sapling (T)							1											
<i>Ficus natalensis</i> (T)					+		1											
<i>Haemanthus albiflos</i> (F)						+	1											
<i>Maytenus mossambicensis</i> (T)							1											
<i>Maytenus undata</i> sapling (T)							1	+										
<i>Putterlickia verrucosa</i> sapling (S/T)							1											
<i>Rhus rehmanniana</i> (T)							1			+								
<i>Sansevieria</i> sp. (X)					+		1											
<i>Acridocarpus natalitius</i> (S)							1											
<i>Ehretia rigida</i> (S)							1											
<i>Euphorbia triangularis</i> (T)							1											
<i>Osyridicarpus schimperianus</i> (SU)							1											
<i>Rhus gueinzii</i> sapling (S)							1											
<i>Rhus</i> sp. sapling (T)							1											
<i>Tecomaria capensis</i> sapling (S)							1											
11. Differential species for communities 5 & 6																		
<i>Chaetacme aristata</i> (T)					+		1	1	+									
<i>Oplismenus hirtellus</i> (G)							1	1	+		+				+			
<i>Jasminum streptopus</i> (S/C)					+		1	1			+							
<i>Acalypha glabrata</i> (T)							1	1			+							
<i>Dracaena hookeriana</i> (S)					+		+	1										
<i>Maerua racemulosa</i> sapling (S)							+	1			+							
<i>Pellaea viridis</i> (P)							+	1			+							
<i>Sideroxylon inerme</i> (T)							1	+	+									
12. Differential species for communities 4, 5 & 6																		
<i>Canthium inerme</i> sapling (T)					+		+	1	1	+		+		+				
<i>Cussonia spicata</i> sapling (T)							4		2			+						

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (CL) - Climber; (G) - Grass;
 (R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte
 (S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;
 (/c) - Climbing form

APPENDIX — Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

												1	1	1	1	1	1	1
Community number												1	2	3	4	5	6	7
13. Differential species for communities 3, 4, 5 & 6																		
<i>Uvaria caffra</i> (S/C)							3	4	1	3	+	+	+					+
<i>Brachylaena discolor</i> (S/T)	+	3							1	2	+	+	+					
<i>Rhoicissus tomentosa</i> (S/C)			1						1	2	+	+	+	+				
<i>Rothmannia globosa</i> sapling (T)				2	+	1	1	+			+							+
<i>Rothmannia globosa</i> (T)				3	+	1	1				+							
<i>Sansevieria hyacinthoides</i> (X)			1						1	1			+					
<i>Pupalia atropurpurea</i> (F)			2							1								
<i>Senecio tamoides</i> (F/C)			+						1	+	+		+					
<i>Cestrum laevigatum</i> sapling (T/S) *			+							1	+	+						
<i>Clausena anisata</i> (S)					+						1	+						
<i>Rhoicissus digitata</i> (S/C)	2	+						+	2	+	+							
14. <i>Dovyalis rhamnoides</i> - <i>Hippobromus pauciflorus</i> low thicket																		
<i>Cissampelos torulosa</i> (S/C)										2		+						
<i>Coddia rudis</i> sapling (S)				+						+	+		+					
<i>Dovyalis rhamnoides</i> (S)										+	2							
<i>Kraussia floribunda</i> sapling (T)											1		+					
<i>Kraussia floribunda</i> (T)											2							
<i>Scolopia zeyheri</i> (T)											2							
<i>Trimeria grandifolia</i> seedlings (T)											1		+					
<i>Zanthoxylum capense</i> seedlings (T)											1			+				
<i>Canthium ciliatum</i> (S)											1							
<i>Diospyros whyteana</i> sapling (S)											1							
<i>Maytenus undata</i> (T)											1							
<i>Schoenoxiphium lehmannii</i> (F)											1							
15. Differential species for communities 6 & 7																		
<i>Coddia rudis</i> (S)				+						2	1							
<i>Hippobromus pauciflorus</i> (T)										1	2		+					
<i>Acokanthera oblongifolia</i> sapling (T)									+	1	1	+						
<i>Trimeria grandifolia</i> (T)											1	1	+					
<i>Zanthoxylum capense</i> (T)											+	1		+				
16. Differential species for communities 3, 4, 5, 6 & 7																		
<i>Calpurnia aurea</i> (S)											1	2	1					
<i>Dicliptera heterostegia</i> (F)											+	1	1	1				
<i>Celtis africana</i> (T)												1	+	+				+
<i>Scutia myrtina</i> (S/C)											1	+		1	2	1	+	
<i>Euclea natalensis</i> (T)											1		+	+	1	2		
<i>Grewia caffra</i> (S)											1			+	+		+	
17. Differential species for communities 5, 6, 7 & 8																		
<i>Dovyalis rhamnoides</i> sapling (S)												+	2	2				
<i>Trimeria grandifolia</i> sapling (T)													2	+				+
<i>Clausena anisata</i> sapling (S)												1	2	2	2		+	
<i>Canthium ciliatum</i> sapling (S)												+			+	+		+

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1
18. Differential species for communities 3, 4, 5, 6, 7 & 8																	
<i>Cyphostemma hypoleucum</i> (F/C)			2	2	2	1	1	2		+		+		+			
<i>Euclea natalensis</i> sapling (T)			1		3	1	1	3	2								
<i>Strelitzia nicolai</i> sapling (T)			+	+	1			+	+					+	+		
19. <i>Acacia gerrardii</i> - <i>Rhus chirindensis</i> tall closed shrubland//low/short thicket mosaic																	
<i>Maytenus senegalensis</i> sapling (T)										1				+			+
<i>Pereskia aculeata</i> (CL) *					+					1							
<i>Acacia gerrardii</i> (T)							+			1							
<i>Acacia nilotica</i> sapling (T)										1		+					
<i>Amaranthus viridis</i> (F) *										1				+			
<i>Microglossa mespilifolia</i> (S/C)								+		1							
<i>Polygala natalensis</i> (F)										1							
<i>Rhus chirindensis</i> seedlings (T)							+			1							
<i>Achyroopsis leptostachya</i> (SU)										1							
<i>Buddleja saligna</i> sapling (T)										1							
<i>Crassula</i> sp. (F)										1							
<i>Dombeya rotundifolia</i> sapling (T)										1							
<i>Eucalyptus grandis</i> (T) *										1							
<i>Eustachys paspaloides</i> (G)										1							
<i>Spirostachys africana</i> sapling (T)										1							
<i>Vitellariopsis marginata</i> sapling (T)										1							
<i>Combretum molle</i> sapling (T)							+	+	1				+		+		
20. Differential species for communities 6, 7, 8 & 9																	
<i>Hippobromus pauciflorus</i> sapling (T)										2	2		1			+	
<i>Putterlickia verrucosa</i> (S/T)										2	2		1				+
<i>Rhoicissus tridentata</i> (S/C)							+			1	1	+	1	+		+	
<i>Anastrabe integerrima</i> (T)										2	+		1				
<i>Dalbergia obovata</i> sapling (T/C)					+					1		2	1		+		+
<i>Baphia racemosa</i> (T)					+	+				1		+	1				
<i>Panicum</i> sp. (G)										1		+	1		+	+	+
<i>Passiflora suberosa</i> (CL) *							+			2	+		1		+		
<i>Buddleja saligna</i> (T)										2	1		1				
<i>Combretum molle</i> (T)					+					1	+	2	1				
<i>Rhus pentheri</i> sapling (T)										1	+	+	1				
<i>Rhus rehmanniana</i> sapling (T)										1					+		
<i>Dombeya rotundifolia</i> (T)										+			1			+	
<i>Spirostachys africana</i> (T)										1			1				
<i>Tecomaria capensis</i> (S)										+	+		1	+			
<i>Rhus chirindensis</i> (T)							+			1	2	1	+				
<i>Maytenus heterophylla</i> sapling (T)							+	+	+	+	1						
<i>Apodytes dimidiata</i> (T)							+			+			1				
<i>Clerodendrum glabrum</i> (T)							+			+			1				
<i>Bridelia micrantha</i> sapling (T)							+			+			1				
<i>Hibiscus fuscus</i> (F)										+		+	1				

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (CL) - Climber; (G) - Grass;
 (R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte
 (S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;
 (/c) - Climbing form

APPENDIX — Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1
21. Differential species for communities 5, 6, 7, 8 & 9																	
<i>Protasparagus virgatus</i> (CL)				+	1	1	5	3	2		+	+					
<i>Jasminum multipartitum</i> (S/C)					1	2	+	+	1								
<i>Hibiscus calyphyllus</i> (S)					1	2		+	1		+						
<i>Apodytes dimidiata</i> sapling (T)		+		+	1	1			1				+	+			
<i>Scadoxus puniceus</i> (F)					1	1	2		1	+							
<i>Bridelia micrantha</i> (T)					1	+	+		1				+				
<i>Dalbergia obovata</i> seedlings (T/C)			+		1		2		1		+				+		
<i>Trema orientalis</i> (T)		+			1				1				+	+			
<i>Calpurnia aurea</i> sapling (S)					1	+			1								
<i>Maytenus heterophylla</i> (T)					1		+	+	1								
<i>Sapium integerrimum</i> (T)			+		1		+	+	1								
<i>Apodytes dimidiata</i> seedlings (T)					+		1	+	+	+							
<i>Dalechampia capensis</i> (SU/C)					1			+	1								
<i>Pavetta lanceolata</i> sapling (T/S)					+				1	+			+				
<i>Trema orientalis</i> sapling (T)					+				1				+				
<i>Montanoa hibiscifolia</i> (S) *					+				1	+							
22. Differential species for communities 3, 4, 5, 6, 7, 8 & 9																	
<i>Isoglossa woodii</i> (F/SU)					3	3	+	3	1	+	1						
<i>Monanthotaxis caffra</i> (S/C)					+	4	4	2	2	2	+	1					
<i>Dalbergia armata</i> (T/C)					1	+	3	1	1	2	2	1	+		+	+	
<i>Entada spicata</i> (S/C)					1		+	2	2		1				+		
<i>Aneilema aequinoctiale</i> (F)		+	1		1		1	+		1	+						
<i>Raphia racemosa</i> sapling (T)					2	+	1	2		1							
<i>Grewia occidentalis</i> (S)		+	1			+	1		+	1							
<i>Tragia durbanensis</i> (F)		+			+				+	1			+				+
<i>Acacia kraussiana</i> (S/C)					1			+		1							
<i>Dioscorea cotinifolia</i> (CL)					+	3	1	2	+	1							
23. Differential species for communities 3, 4, 5, 6, 7, 8, 9 & 10																	
<i>Mangifera indica</i> (T) *					+		1	+	+	1	1		+	+			
<i>Diospyros lycioides</i> sapling (S)						+	+	1		+	1	+		+	+		1
<i>Syzygium cuminii</i> (T) *						1		+		+			+				
<i>Pavonia burchellii</i> (F)										1	1						
<i>Dalbergia obovata</i> (T/C)		+	1	2	4	2	2	2	1	2	1	1	+	+	+		
<i>Erythrina lysistemon</i> (T)					1		+	+		1	1		+	+			
24. <i>Bothriochloa insculpta</i> - <i>Hyparrhenia hirta</i> short closed grassland																	
<i>Bothriochloa insculpta</i> (G)																	
<i>Leucaena leucocephala</i> (S) *																	
25. <i>Phragmites australis</i> - <i>Cyperus immensus</i> short closed grassland//tall/high closed shrubland//tall closed reedbed mosaic																	
<i>Phragmites australis</i> (R)																	
<i>Phragmites</i> sp. (R)																	
<i>Rumex rhodesius</i> (F)																	
<i>Amaranthus spinosus</i> (F) *																	
<i>Polygonum hydropiper</i> (F/S) *																	
<i>Polygonum senegalense</i> (F/S)																	

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (CL) - Climber; (G) - Grass;

(R) - Reed; (GED) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1
26. <i>Senecio madagascariensis</i> - <i>Panicum maximum</i> tall closed grassland//short closed grassland mosaic																		
<i>Senecio madagascariensis</i> (F)									+	+	+	1				+		
<i>Ambrosia maritima</i> (F) *												1	1					
<i>Eleusine indica</i> (G)									+		+	1						
<i>Ambrosia artemisiifolia</i> (F) *												1			+			
<i>Asclepias physocarpa</i> (F)									+			1						
<i>Conyza chilensis</i> (F) *												1				+		
<i>Cyperus esculentus</i> (C)								+				1			+			
<i>Widorella linifolia</i> (F)												1						
<i>Aster squamatus</i> (F) *											+	1			+			
<i>Malvastrum coromandelianum</i> (F) *												1						
<i>Solanum nigrum</i> (F) *												1	1					
<i>Sonchus oleraceus</i> (F) *												1				+		
<i>Crocosmia aurea</i> (F)												1			+			
<i>Hypochoeris glabra</i> (F) *										+		1						
<i>Paspalum notatum</i> (G) *												1					+	
<i>Chamaesyce hypericifolia</i> (F) *												1						
<i>Cissampelos mucronata</i> (S/C)												1						
<i>Corchorus trilocularis</i> (F) *												1						
<i>Eragrostis ciliaris</i> (G)												1						
<i>Hibiscus</i> sp. (F)								+				1						
<i>Hibiscus trionum</i> (F)												1			+			
<i>Jacquemontia tamnifolia</i> (F/C)								+				1						
<i>Lagenaria macrarena</i> (F/C)											+	+	+					
<i>Lycopersicon</i> sp. (F) *											+	1						
<i>Nemesia caerulea</i> (F)											+	1						
<i>Paspalum scrobiculatum</i> (G)						+						1						
<i>Stenotaphrum secundatum</i> (G)												1						
<i>Tridax procumbens</i> (F) *												1			+			
<i>Acalypha ecklonii</i> (F)												1						
<i>Amaranthus dubius</i> (F) *												1						
<i>Chrysanthemoides monilifera</i> seedlings (S)											+	+						
<i>Coreopsis lanceolata</i> (F) *												1						
<i>Cyperus natalensis</i> (C)												1						
<i>Neelilotus indica</i> (F) *												1						
<i>Pelargonium alchemilloides</i> (F)												1						
<i>Rubus pinnatus</i> (S/C)												1						
27. Differential species for communities 12 & 13																		
<i>Verbena bonariensis</i> (F) *									+			1	1				+	
<i>Lepidium bonariense</i> (F) *												1	1					
<i>Laportea peduncularis</i> (F)												2	1					
<i>Achyranthes aspera</i> (F) *						+						1	1			+		
28. Differential species for communities 11, 12 & 13																		
<i>Mariscus sumatrensis</i> (C)									+	1		+	1			+		+
<i>Hibiscus cannabinus</i> (S)												2	1					
<i>Sesbania sesban</i> (S)											1	2	1		+	+		+
<i>Cyperus immensus</i> (C)						+					+	+	2	1				
<i>Indigofera spicata</i> (F)												2	+	1				
<i>Sporobolus pyramidalis</i> (G)											+	+			+		+	
<i>Indigofera trita</i> (F)									+	1								
<i>Pennisetum purpureum</i> (R) *					+					+			1	1				
<i>Senna didymobotrya</i> (S) *										+			1	+				

* Alien and naturalised species

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(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1
29. Differential species for communities 9, 10, 12 & 13																		
<i>Cynodon dactylon</i> (G)									+	1	+	2	1	2		+	+	
<i>Ageratum conyzoides</i> (F) *					+	+				1		2	1			+		
<i>Oxalis corniculata</i> (F) *										1		+	1					+
<i>Ipomoea congesta</i> (F/C) *								+		1	+	1				+		
<i>Paspalum urvillei</i> (G) *										1			1					
<i>Dichrostachys cinerea</i> sapling (S)								+		1		+	1			+	+	
<i>Tithonia diversifolia</i> (F) *							+			1			1					
<i>Canna generalis</i> (F) *										1			1	1				
<i>Rhus chirindensis</i> sapling (T)					+					1		+	1					
<i>Chloris gayana</i> (G)										1	+		+	1				
<i>Dichrostachys cinerea</i> (S)				+						1			+	+				
<i>Nidorella</i> sp. (F)										1	+		+	1				
<i>Macrotyloma axillare</i> (F/C)										+		+	1			+		
<i>Morus</i> sp. (T) *								+		1			1					
<i>Pseudarthria hookeri</i> sapling (SU)										+	+		1			+		
<i>Conyza canadensis</i> (F) *										+			1		+			
<i>Tephrosia polystachya</i> (S)										+	1		1					
<i>Syzygium cordatum</i> (T)										+			1					
30. Differential species for communities 5, 7, 9, 10, 12 & 13																		
<i>Melia azedarach</i> (T) *			+			1	+	2		2	1			1		+		+
<i>Melia azedarach</i> seedlings (T) *					+	1		+		1	1		+	+				
<i>Cardiospermum grandiflorum</i> (CL) *			+			1				1	+		2	+		+		
<i>Convolvulus farinosus</i> (F)						+								1	+	+		
<i>Clerodendrum glabrum</i> sapling (T)						1		+	+				1					
31. Differential species for communities 3, 5, 7, 8, 9, 10 & 13																		
<i>Setaria megaphylla</i> (G)			+		+	+	+	1	+	2	+	1	1		1		+	
<i>Solanum auriculatum</i> (S) *						1		+	+		1	1		+	1			
<i>Ipomoea</i> sp. (F/C)			+			1		1	+		+	+		+	1			+
<i>Passiflora foetida</i> (CL) *						1					+			+	+			
32. <i>Phyllanthus burchellii</i> - <i>Digitaria eriantha</i> short closed grassland//tall sparse/closed shrubland mosaic																		
<i>Phyllanthus burchellii</i> (F)															+	3		
<i>Alectra sessiliflora</i> (F)																2		
<i>Anthospermum herbaceum</i> (SU)																1		+
<i>Eugenia albanensis</i> (T)																1		+
<i>Hyparrhenia dichroa</i> (G)															+	1		
<i>Leucas lavandulifolia</i> (F)																+	1	
<i>Rumex sagittatus</i> (F)																+	1	
<i>Saccharum officinarum</i> (G) *																+	1	
<i>Senecio polyanthemoides</i> seedlings (F)								+									1	
<i>Wedelia trilobata</i> (F) *									+								1	
<i>Achyroopsis avicularis</i> (SU)																	1	
<i>Ceratotheca triloba</i> (F/C)																	1	
<i>Desmodium dregeanum</i> (F)																	1	
<i>Indigofera arrecta</i> (S)															+		+	
<i>Ricinus communis</i> seedlings (S) *																	1	
<i>Salacia kraussii</i> (SL)																	1	

* Alien and naturalised species

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APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
33. Differential species for communities 12, 13 & 14																		
<i>Conyza floribunda</i> (F) *																		
<i>Imperata cylindrica</i> (G)																		
<i>Lantana camara</i> seedlings (S) *									+									
<i>Eriosema parviflorum</i> (F)																		
<i>Triumfetta rhomboidea</i> (F)									+									
<i>Digitaria natalensis</i> (G)																		
<i>Lactuca indica</i> (F) *																		
<i>Richardia brasiliensis</i> (F) *									+									
<i>Zornia capensis</i> (F/C)																		
<i>Cyperus distans</i> (C)																		
<i>Helichrysum longifolium</i> (F)																		
<i>Chamaesyce hirta</i> (F)																		
<i>Pycnus polystachyos</i> (C)																		
<i>Andropogon eucomus</i> (G)																		
<i>Gomphrena celosioides</i> (F) *																		
<i>Hyparrhenia filipendula</i> (G)																		
<i>Sesbania punicea</i> (S) *																		
<i>Tagetes minuta</i> seedlings (F) *																		
<i>Cyperus sphaerospermus</i> (C)																		
<i>Conyza</i> sp. (F) *																		
34. Differential species for communities 10, 11, 13 & 14																		
<i>Cassia mimosoides</i> (F)																		
<i>Triumfetta</i> sp. (F)																		
<i>Polygala hottentotta</i> (F)																		
<i>Sonchus</i> sp. (F)																		
35. Differential species for communities 3, 5, 6, 7, 8, 9, 10, 11, 12, 13 & 14																		
<i>Tagetes minuta</i> (F) *																		
<i>Hewittia sublobata</i> (F/C)																		
<i>Crotalaria lanceolata</i> (F)																		
<i>Melia azedarach</i> sapling (T) *																		
<i>Vigna vexillata</i> (F)																		
<i>Berkheya</i> sp. (F)																		
<i>Helichrysum panduratum</i> (F/S)																		
<i>Helichrysum cymosum</i> (F)																		
<i>Helichrysum kraussii</i> (F)																		
<i>Laggera alata</i> (F)																		
<i>Desmodium setigerum</i> (F)																		
<i>Hibiscus surattensis</i> (S)																		
<i>Acalypha petiolaris</i> (F)																		
<i>Glycine wightii</i> (F/C)																		
<i>Acacia</i> sp. sapling (T)																		
<i>Oxalis</i> sp. (F) *																		
<i>Brachiaria chusqueoides</i> (G)																		
<i>Commelina erecta</i> (F)																		
<i>Asystasia gangetica</i> (F)																		
<i>Chrysanthemoides monilifera</i> (S)																		
<i>Cheilanthes viridis</i> (P)																		
<i>Smilax kraussiana</i> (S/C)																		
<i>Brachylaena discolor</i> sapling (S/T)																		
<i>Erythrina lysistemon</i> sapling (T)																		

* Alien and naturalised species

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APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1
36. <i>Sutera kraussiana</i> - <i>Aristida junciformis</i> low/short closed grassland																		
<i>Oxalis latifolia</i> (F) *																1		
<i>Sutera kraussiana</i> (F)																1		
<i>Indigofera</i> sp. (F)																1	+	
37. Differential species for communities 14 & 15																		
<i>Lobelia erinus</i> (F)									+							1	1	+
<i>Rhynchosia caribaea</i> (F)							+									1	1	
38. Differential species for communities 12, 13, 14 & 15																		
<i>Digitaria eriantha</i> (G)									+					1	2	1		+
<i>Helichrysum</i> sp. (F)									+				+		1	1		+
<i>Leonotis ocymifolia</i> (S)															1	+	1	
<i>Cymbopogon excavatus</i> (G)									+				+	+	1			
<i>Physalis viscosa</i> (F) *									+		2	+	2	1	1			1
39. Differential species for communities 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 & 15																		
<i>Senecio polyanthemoides</i> (F)										+	2	1	1		2	2	2	2
<i>Sorghum bicolor</i> (G)											2	1	+	2	1	2	1	1
<i>Digitaria</i> sp. (G)											2	1	+		1	2		+
<i>Berkheya bipinnatifida</i> (S)					+		1	1	3	2	1	+		1	1			+
<i>Psidium guajava</i> (T) *							+	1	+	+	1	1	+		+	1		
<i>Commelina</i> sp. (F)						+		1	1	+	+	1	1		1	1	+	+
<i>Cyperus albobristatus</i> (C)							+	1	2	3	2	2	3	2	1	+	+	+
<i>Chromolaena odorata</i> (S) *								3	2		3	3	5	4	4	2	+	2
<i>Albizia adianthifolia</i> (T)								2	1		2	+		1	+		+	1
40. <i>Hypoxis gerrardii</i> - <i>Alloteropsis semialata</i> low closed grassland																		
<i>Alepeidea</i> sp. (F)																	5	+
<i>Hypoxis gerrardii</i> (GEO)									+								5	
<i>Alloteropsis semialata</i> (G)																	5	
<i>Becium obovatum</i> (F)																	5	
<i>Euphorbia natalensis</i> (F)																	5	
<i>Tristachya leucothrix</i> (G)																	5	
<i>Aster bakeranus</i> (F)									+								5	+
<i>Berkheya speciosa</i> (F)																	1	5
41. <i>Helichrysum aureum</i> - <i>Themeda triandra</i> short closed grassland																		
<i>Helichrysum aureum</i> (F)																	+	2
<i>Monocymbium cerasiiforme</i> (G)																		2
<i>Tephrosia kraussiana</i> (F)																		2

* Alien and naturalised species

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(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1
42. Differential species for communities 13, 14, 15, 16 & 17																	
<i>Helichrysum cephaloideum</i> (F)																+ 1 + 2	
<i>Cassia</i> sp. (F)																+ + + 2	
<i>Cyperus obtusiflorus</i> (C)																+ 1 + + 2	+
<i>Selago woodii</i> (SL)																+ 1	2
<i>Eragrostis capensis</i> (G)																+	2 +
<i>Themeda triandra</i> (G)									+							+ + 1	2
<i>Eriosema salignum</i> (F)																1 +	+ 2 +
<i>Aristida junciformis</i> (G)										1 1						1 2 2 + 3	
43. <i>Dianthus zeyheri</i> - <i>Eragrostis curvula</i> low/short closed grassland																	
<i>Dianthus zeyheri</i> (F)																	2
<i>Thesium pallidum</i> (F)																	2
<i>Crabbea hirsuta</i> (SL)																	2
44. Differential species for communities 14, 15, 16, 17 & 18																	
<i>Hypoxis acuminata</i> (GEO)									+	+						1 5	1
<i>Thunbergia striplificifolia</i> (F)									+							+ + + 2 2	
<i>Aeschynomene micrantha</i> (F)																+ 1 1	3 2
45. Differential species for communities 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 & 18																	
<i>Chaetacanthus burchellii</i> (SL)																	3 4
<i>Gerbera ambigua</i> (F)																+ 1 5	+ 2
<i>Scabiosa columbaria</i> (F)																+ 1 + + 2	
<i>Aspilia natalensis</i> (F)									+		+					+	2
<i>Cymbopogon</i> sp. (G)										+						+	2
<i>Indigofera hilaris</i> (F)																1	+ 2
<i>Eriosema cordatum</i> (F)																+ 1	+ 1
<i>Tephrosia macropoda</i> (F)																2 1	+ 2 2
<i>Setaria sphacelata</i> (G)								+		+	+					1 1 + + 2 2	
<i>Vernonia capensis</i> (F)									+	+						1 2 + + 2	
<i>Hypoxis rooperi</i> (GEO)									+	+	+					1 2	2
<i>Commelina africana</i> (F)																1 + +	+ 2
<i>Cassia plumosa</i> (F)																1 +	2
<i>Gerbera piloselloides</i> (F)																+ + 2	1 1 1 2 2
<i>Sonchus wilmsii</i> (F)																+ + 2	1 1 2 2 2
<i>Sida rhombifolia</i> (F)																+ 1 + + 1 3 1 +	+ 2
<i>Stachys natalensis</i> (F)																1 1 2	1 1 + 3
<i>Cymbopogon validus</i> (G)									+							1 1 +	1 1 1 + 2 1
<i>Ruellia cordata</i> (SU)																+ 1 1 +	+
<i>Acacia nilotica</i> (T)									+							1 + 2	+ 1
<i>Acalypha peduncularis</i> (F)																1 +	1 + + 2
<i>Hibiscus pusillus</i> (F)																1 + +	+ 1 2
<i>Rhynchelytrum repens</i> (G)									+							1 + 2	2 2 1 + + 2
<i>Nidorella auriculata</i> (F)																+ 1 1 + + 1 4 4 +	
<i>Sporobolus africanus</i> (G)																+ 1 + 2 + 2 1 2	+ 1
<i>Bidens pilosa</i> (F) *																1 + +	2 2 1
<i>Albizia adianthifolia</i> sapling (T)									+							1 1	1 1 1 + +
<i>Chromolaena odorata</i> seedlings (S) *																+ + 1 +	1 1 1

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
45. Differential species for communities 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 & 18 (continued)											1	1	1	1	1	1	1	1
<i>Helichrysum decorum</i> (F)											1	1	+	1	2	1	+	
<i>Helichrysum nudifolium</i> (F)											+	1	1		1	1	1	1
<i>Ipomoea cairica</i> (F/C)											+	1	1		2	1	+	1
<i>Senecio variabilis</i> (F)											+	1	+		1	1	2	+
<i>Ricinus communis</i> (S) *											1	+		2	1	+	1	+
<i>Senecio</i> sp. (F)											1			1	2	1		+
<i>Hyparrhenia</i> sp. (G)											1	+	+		+	+	1	+
<i>Desmodium gangeticum</i> (F)											+	+	1		+	1		1
<i>Lantana rugosa</i> (F/S)											1	2			1			+
<i>Senecio chrysocoma</i> (F)											+	+	1	1	1	2	1	+
<i>Desmodium incanum</i> (F)											+	1	+	1	1	+		2
<i>Centella asiatica</i> (F)											+	1	+	+	1	1	1	2
<i>Teramnus labialis</i> (F)											+	1	1	4	1	1	2	3
<i>Hyparrhenia hirta</i> (G)											+	1	1	2	1	2	2	+
<i>Xysmalobium undulatum</i> (F)											1	+	+		+	+	+	2
<i>Psidium guajava</i> sapling (T) *											+	1	2	2	1	1	1	1
<i>Eragrostis curvula</i> (G)											1	2	1	1	2	3	2	3
<i>Panicum maximum</i> (G)											+	1	+	2	+	1	2	2
<i>Lantana camara</i> (S) *											2	3	3	2	1	2	4	4
46. Trees																		
<i>Abrus precatorius</i>											*				*	*	*	2
<i>Dalbergia armata</i> seedling (C) **											+	+			+			
<i>Schinus terebinthifolius</i> sapling *														1	1			
<i>Vangueria infausta</i> sapling														+	+	+	+	+
<i>Albizia adianthifolia</i> seedlings														+	+	+		
<i>Allophylus melanocarpus</i>														+	+	+	+	
<i>Antidesma venosum</i>											+			+				
<i>Dalbergia armata</i> sapling (C)														+	+			
<i>Grewia occidentalis</i> sapling											+			+				
<i>Maytenus nemorosa</i>											+	+	+	+				
<i>Schinus terebinthifolius</i> *														+	+	+	+	
<i>Tephrosia polystachya</i> seedlings														+	+	+	+	
<i>Chrysanthemoides monilifera</i> sapling														+	+			
<i>Heteropyxis natalensis</i>														+	+	+		
<i>Hippobromus pauciflorus</i> seedlings														+	+	+		
<i>Leucaena leucocephala</i> sapling *														+	+	+		
<i>Maytenus senegalensis</i>														+		+		
<i>Morus</i> sp. sapling *														+	+	+		
<i>Sapium integerrimum</i> sapling														+	+			
<i>Strychnos madagascariensis</i> sapling														+	+			
<i>Acacia ataxacantha</i> (C)														+	+			
<i>Acacia gerrardii</i> sapling														+	+			
<i>Acacia</i> sp. seedling														+				
<i>Acalypha glabrata</i> seedlings														+	+			
<i>Allophylus melanocarpus</i> sapling														+	+			
<i>Allophylus natalensis</i> sapling														+				
<i>Anastrebe integerrima</i> sapling														+				
<i>Baphia racemosa</i> seedlings														+	+			

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1																	
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
46. Trees (continued)																		
<i>Berkheya bipinnatifida</i> seedlings									+									+
<i>Berkheya</i> sp. seedlings									+	+								
<i>Berkheya umbellata</i>					+													+
<i>Bridelia micrantha</i> seedlings									+	+								
<i>Cassia coluteoides</i> sapling *					+				+									
<i>Cassia</i> sp. seedlings *									+							+		
<i>Clausena anisata</i> seedlings					+		+											
<i>Coddia rudis</i> seedling									1									
<i>Cussonia nicholsonii</i>									+	+								
<i>Diospyros lycioides</i> seedlings									+	+								
<i>Diospyros lycioides</i>									+	+								
<i>Diospyros villosa</i>									+	+								
<i>Dombeya tilices</i> sapling									+	+								
<i>Entada spicata</i> sapling (C)				+		+												
<i>Erythrococca berberidea</i>									+	+								
<i>Erythrina</i> sp. sapling									+	+								
<i>Ficus natalensis</i> sapling					+				+									
<i>Furcraea foetida</i> *						+			+									
<i>Gnidia macropetala</i>									+						+			
<i>Hibiscus pedunculatus</i>						+	+											
<i>Hibiscus platycalyx</i>						+			+									
<i>Heteropyxis natalensis</i> sapling									2									
<i>Litsea sebifera</i> seedlings *										+	+							
<i>Maerua cafra</i> sapling									+	+								
<i>Mangifera indica</i> sapling *						+			+									
<i>Nuxia floribunda</i>									+				+					
<i>Ochna natalitia</i> sapling					+	+												
<i>Ozerva paniculosa</i>						+			+									
<i>Peddiea africana</i> sapling		+		+														
<i>Phoenix reclinata</i> sapling		+							+									
<i>Pseudarthria hookeri</i> seedlings									+								+	
<i>Rhus nebulosa</i> sapling									+					+				
<i>Ruellia patula</i>														+		+		
<i>Sapium ellipticum</i>					+	+												
<i>Sesbania bispinosa</i> *									+				+					
<i>Syzygium cuminii</i> sapling *									+			+						
<i>Tarenna pavettoides</i> sapling					+				+									
<i>Turraea floribunda</i>					+				+									
<i>Turraea obtusifolia</i>					+	+												
<i>Vangueria infausta</i>																	+	+
<i>Vitellariopsis marginata</i>					+				+									
<i>Vitex trifolia</i> *									+				+					
<i>Zanthoxylum capense</i> sapling					+				+									
<i>Abrus precatorius</i> seedlings									+									
<i>Acacia karroo</i> sapling									+									
<i>Acacia karroo</i> seedlings																	+	
<i>Acacia karroo</i>										+								
<i>Acacia robusta</i> sapling																+		
<i>Acacia sieberiana</i>									+									
<i>Acalypha sonderiana</i>						+												
<i>Acokanthera oblongifolia</i> seedlings					+													
<i>Acokanthera oblongifolia</i>									+									

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1 1 1 1 1 1 1 1 1																	
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
46. Trees (continued)																		
<i>Acridocarpus natalitius</i> sapling						+												
<i>Albizia lebbeck</i> sapling *							+											
<i>Allophylus natalensis</i> seedlings			+															
<i>Anastrebe integririma</i> seedlings								+										
<i>Ardisia crenulata</i> *							+											
<i>Arthrocnemum perenne</i>	+																	
<i>Asclepias fruticosa</i>																+		
<i>Azima tetracantha</i>										+								
<i>Berkheya rhapontica</i>																	+	
<i>Berkheya umbellata</i> seedlings														+				
<i>Brachylaena discolor</i> seedlings								+										
<i>Brachylaena uniflora</i>										+								
<i>Bruguiera gymnorhiza</i> sapling	+																	
<i>Burchellia bubalina</i>								+										
<i>Calpurnia aurea</i> seedlings						+												
<i>Canthium gueinzii</i>						+												
<i>Canthium pauciflorum</i> sapling									+									
<i>Carissa macrocarpa</i>															+			
<i>Cassia bicapsularis</i> *																+		
<i>Cassia floribunda</i> sapling *									+									
<i>Cassipourea gerrardii</i>							+											
<i>Cassia hirsuta</i> *															+			
<i>Cassia occidentalis</i> sapling *																+		
<i>Cassia occidentalis</i> *												+						
<i>Casuarina equisetifolia</i> *									+									
<i>Catunaregam spinosa</i>									+									
<i>Cestrum laevigatum</i> *							+											
<i>Cestrum</i> sp. sapling *										+								
<i>Chrysophyllum viridifolium</i>						+												
<i>Clerodendrum glabrum</i> seedlings									+									
<i>Clerodendrum myricoides</i> sapling														+				
<i>Clusia cordata</i>																	+	
<i>Clusia disceptata</i>																		+
<i>Clusia pulchella</i> sapling									+									
<i>Cola natalensis</i>							+											
<i>Combretum bracteosum</i>						+												
<i>Combretum kraussii</i> sapling								+										
<i>Combretum molle</i> seedlings									+									
<i>Combretum</i> sp. seedlings																	+	
<i>Commiphora harveyi</i> sapling						+												
<i>Commiphora</i> sp.						+												
<i>Croton bonplandianus</i> *															+			
<i>Cryptolepis oblongifolia</i>							+											
<i>Cryptocarya woodii</i>			+															
<i>Cussonia sphaerocephala</i> sapling						+												
<i>Cussonia sphaerocephala</i>									+									
<i>Dalechampia volubilis</i> (C)						+												
<i>Delonix regia</i> sapling *														+				
<i>Diospyros natalensis</i> sapling						+												
<i>Diospyros natalensis</i>			+															
<i>Diospyros</i> sp. sapling														+				
<i>Dracaena hookeriana</i> seedlings	+																	

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1
46. Trees (continued)																	
<i>Drypetes natalensis</i> seedlings						+											
<i>Dyschoriste depressa</i>														+			
<i>Ekebergia capensis</i>					+												
<i>Erythrococca berberidea</i> sapling					+												
<i>Erythrococca natalensis</i>					+												
<i>Erythroxylum pictum</i>						+											
<i>Erythrina</i> sp.									+								
<i>Eucalyptus</i> sp. sapling *									+								
<i>Euclea crispa</i> sapling								+									
<i>Euclea divinorum</i> sapling											+						
<i>Euclea natalensis</i> seedlings							+										
<i>Euclea schimperii</i> sapling							+										
<i>Euclea</i> sp. seedlings								+									
<i>Eugenia</i> sp. sapling							+										
<i>Eugenia</i> sp.																+	
<i>Eugenia uniflora</i> sapling *		+															
<i>Eugenia uniflora</i> seedlings *									+								
<i>Euphorbia geniculata</i>														+			
<i>Euphorbia heterophylla</i> *														+			
<i>Euphorbia ingens</i>							+										
<i>Euphorbia pulcherrima</i> *									+								
<i>Euphorbia tirucalli</i>								+									
<i>Euryops</i> sp.																+	
<i>Ficus craterostoma</i>									+								
<i>Ficus sur</i> sapling															+		
<i>Ficus sur</i>									+								
<i>Foeniculum vulgare</i> *												+					
<i>Hibiscus calyphyllus</i> seedlings													+				
<i>Hyperacanthus amoenus</i>						+											
<i>Gnidia anthylloides</i>																	+
<i>Gnidia kraussiana</i>															+		
<i>Gnidia phaeotricha</i>															+		
<i>Helinus integrifolius</i>																+	
<i>Isoglossa ciliata</i>											+						
<i>Isoglossa</i> sp.									+								
<i>Isoglossa woodii</i> seedlings						+											
<i>Lagynias lasiantha</i> sapling						+											
<i>Lagynias</i> sp. sapling		+															
<i>Lantana camara</i> sapling *								+									
<i>Leonotis leonurus</i>																+	
<i>Leonotis</i> sp.									+								
<i>Litsea sebifera</i> sapling *														+			
<i>Litsea sebifera</i> *															+		
<i>Maerua cafra</i>											+						
<i>Maerua nervosa</i>		+															
<i>Maytenus mossambicensis</i> sapling		+															
<i>Maytenus nemorosa</i> sapling				+													
<i>Maytenus nemorosa</i> seedlings		+															
<i>Maytenus peduncularis</i> seedlings					+												
<i>Maytenus peduncularis</i>					+												
<i>Maytenus</i> sp. seedlings									+								
<i>Millettia grandis</i> sapling						+											
<i>Millettia grandis</i>						+											

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;
 (R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte
 (S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;
 (/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1
46. Trees (continued)																	
<i>Monanthotaxis caffra</i> seedlings (C)						+											
<i>Mitriostigma axillare</i>			+														
<i>Ochna natalitia</i>								+									
<i>Ochna</i> sp.						+											
<i>Olea woodiana</i>						+											
<i>Orcia bachmannii</i> sapling				+													
<i>Oxyanthus pyriformis</i>						+											
<i>Pachystigma latifolium</i>																	+
<i>Pavetta inandensis</i> sapling						+											
<i>Pavetta lanceolata</i>								+									
<i>Pavetta revoluta</i>			+														
<i>Pavetta</i> sp. sapling						+											
<i>Peddiea africana</i>			+														
<i>Phoenix reclinata</i>															+		
<i>Pittosporum viridiflorum</i> sapling										+							
<i>Pittosporum viridiflorum</i> seedlings								+									
<i>Podocarpus</i> sp. sapling				+													
<i>Psychotria capensis</i> seedlings						+											
<i>Psydrax locuples</i> sapling					+												
<i>Psydrax locuples</i>					+												
<i>Ptaeroxylon obliquum</i> sapling							+										
<i>Raphiolepis indica</i> sapling *								+									
<i>Rawsonia lucida</i>				+													
<i>Rhus gueinzii</i>						+											
<i>Rhus natalensis</i> sapling																+	
<i>Rhus natalensis</i>			+														
<i>Rhus pyroides</i>										+							
<i>Rosa</i> sp. *										+							
<i>Rubus x proteus</i> (C)										+							
<i>Ruttya ovata</i>										+							
<i>Salacia gerrardii</i>				+													
<i>Schinus terebinthifolius</i> seedlings *										+							
<i>Schrebera alata</i> sapling					+												
<i>Sclerocarya caffra</i> sapling										+							
<i>Sclerocarya caffra</i>										+							
<i>Sesbania</i> sp. *																+	
<i>Sesbania hispidosa</i> seedlings *																+	
<i>Sideroxylon inerme</i> sapling									+								
<i>Solanum auriculatum</i> sapling *																+	
<i>Strychnos decussata</i>							+										
<i>Strychnos henningsii</i> sapling						+											
<i>Strychnos spinosa</i> sapling																	+
<i>Strychnos usambarensis</i> sapling			+														
<i>Strychnos usambarensis</i>			+														
<i>Syzygium cordatum</i> sapling										+							
<i>Syzygium jambos</i> sapling *											+						
<i>Syzygium</i> sp. sapling																	
<i>Tabernaemontana ventricosa</i> sapling						+											
<i>Tabernaemontana ventricosa</i>						+											
<i>Teclea gerrardii</i> sapling						+											
<i>Tephrosia polystachya</i> sapling																+	
<i>Tephrosia</i> sp.											+						
<i>Tricalysia sonderiana</i> sapling			+														

* Alien and naturalised species

** (C) - C Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Trees;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1
46. Trees (continued)																	
<i>Trichilia dregeana</i>						+											
<i>Trichilia</i> sp. sapling											+						
<i>Trimeria</i> sp. sapling							+										
<i>Uvaria caffra</i> sapling (C)																	
<i>Vangueria randii</i>																	
<i>Vepris</i> sp. seedlings							+										
<i>Xylothea kraussiana</i> seedlings (S)								+									
<i>Ziziphus mucronata</i> sapling									+								
47. Grasses																	
<i>Panicum deustum</i>										+	+		+				
<i>Bambusa</i> sp. *																	
<i>Echinochloa pyramidalis</i>													1				
<i>Sacciolepis curvata</i>										+			+				
<i>Trachypogon spicatus</i>																+	+
<i>Andropogon appendiculatus</i>																+	
<i>Apochaete hispida</i>																	+
<i>Aristida bipartita</i>											+						
<i>Aristida</i> sp.												+					
<i>Axonopus affinis</i> *													+				
<i>Bothriochloa bladhii</i>																	+
<i>Brachiaria brizantha</i>														+			
<i>Bromus unioloides</i> *										+							
<i>Cenchrus brownii</i> *										+							
<i>Dichanthium aristatum</i>													+				
<i>Digitaria ciliaris</i>										+							
<i>Digitaria diagonalis</i>																	+
<i>Digitaria sanguinalis</i> *													+				
<i>Digitaria setifolia</i>																+	
<i>Diheteropogon amplexans</i>																	+
<i>Ehrharta erecta</i>																+	
<i>Eragrostis inamoena</i>																+	
<i>Eragrostis lappula</i>																	+
<i>Eragrostis plana</i>													+				
<i>Eragrostis racemosa</i>																	+
<i>Eriochloa meyeriana</i>													+				
<i>Eulalia villosa</i>																+	
<i>Leersia hexandra</i>										+							
<i>Paspalum dilatatum</i> *													+				
<i>Sporobolus mauritianus</i>																+	
<i>Sporobolus</i> sp.																+	
<i>Urelytrum agropyroides</i>																	+

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;

(R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte

(S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;

(/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1 1 1 1 1 1 1 1 1																		
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	
48. Sedges																			
<i>Kyllinga</i> sp.						+										+			
<i>Cyperus fenzelianus</i>																+			
<i>Cyperus</i> sp.																+			
<i>Bulbostylis boeckeleriana</i>																+			
<i>Bulbostylis contexta</i>																+			
<i>Fimbristylis complanata</i>																		+	
<i>Fimbristylis dichotoma</i>								+											
<i>Fimbristylis ferruginea</i>													+						
<i>Fimbristylis obtusifolia</i>													+						
<i>Kyllinga elatior</i>								+											
<i>Mariscus dregeanus</i>														+					
<i>Mariscus dubius</i>														+					
<i>Mariscus macrocarpus</i>			+																
<i>Mariscus</i> sp.														+					
<i>Pycneus nitidus</i>																		+	
<i>Pycneus rehmannianus</i>								+											
49. Reeds																			
<i>Typha latifolia</i>														+	+	+			
50. Ferns																			
<i>Nephrolepis exaltata</i> *									+	+									
<i>Thelypteris guienziana</i>								+					+						
<i>Asplenium splendens</i>								+											
<i>Cheilanthes concolor</i>								+											
<i>Cheilanthes viridis</i> seedlings								+											
<i>Mohria caffrorum</i>														+					
51. Forbs and geophytes																			
<i>Senecio glaberrimus</i>								+	+				1	1	+	5	2		
<i>Helichrysum griseum</i>									+	+			+			+	1		
<i>Phaulopsis imbricata</i>					3	1							1						
<i>Rhynchosia</i> sp.							1	1				+	+						
<i>Rhynchosia pentheri</i>													+		+	+	1		
<i>Argyrolobium rupestre</i>								+							+	+	+		
<i>Juncus kraussii</i>	+												1	+					
<i>Lagenaria sphaerica</i> (C)								+				1	+						
<i>Ledebouria floribunda</i>													+				+	1	
<i>Striga bilabiata</i>													+	+				1	
<i>Aloe maculata</i>								+					+				+		
<i>Cyanotis speciosa</i>																	+	+	+
<i>Eriospermum natalense</i>								+								+		+	
<i>Gladiolus</i> sp.								+				+	+						
<i>Ipomoea alba</i> (C) *									+			1							
<i>Justicia flava</i>									+				+					+	
<i>Rhynchosia minima</i>			+									+	+						
<i>Sida dregei</i>								+						+				+	
<i>Triumfetta pilosa</i>						+							1						
<i>Alysicarpus rugosus</i>																+		+	

* Alien and naturalised species

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APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1
51. Forbs and geophytes (continued)																		
<i>Blepharis integrifolia</i>																		1
<i>Ciclospermum leptophyllum</i> *									+					+				
<i>Desmodium adscendens</i>													+			+		
<i>Dicliptera</i> sp.			+						+									
<i>Dicoma speciosa</i>										+								+
<i>Didymodena caffra</i>			+					+										
<i>Dietes</i> sp.									+						+			
<i>Drimiopsis maxima</i>								+										+
<i>Eriosema psoraleoides</i>													+			+		
<i>Hypochoeris brasiliensis</i> *														+		+		
<i>Hypoxis filiformis</i>														+		+		
<i>Ipomoea plebeia</i> (C)														+	+			
<i>Ledebouria</i> sp.									+									+
<i>Mikania cordata</i>														+		+		
<i>Momordica balsamina</i> (C)			+		+													
<i>Pelargonium</i> sp.									+	+								
<i>Pentanisia prunelloides</i>																	+	+
<i>Phyllanthus</i> sp.														+	+			
<i>Rhinacanthus gracilis</i>						+		+										
<i>Senecio erubescens</i>														+		+		
<i>Sigesbeckia orientalis</i> *														+		+		
<i>Stylochiton natalensis</i>									+	+								
<i>Tephrosia linearis</i>														+	+			
<i>Thesium goetzeanum</i>															+			+
<i>Thunbergia dregeana</i>									+	+								
<i>Vernonia hirsuta</i>															+		+	
<i>Achyrocline stenoptera</i>																+		
<i>Ageratum conyzoides</i> seedlings *														+				
<i>Aizoon canariense</i>															+			
<i>Aloe arborescens</i>			+															
<i>Aloe saponaria</i>																		+
<i>Aloe</i> sp.																	+	
<i>Anomatheca laxa</i>														+				
<i>Anthericum galpinii</i>															+			
<i>Aspidoglossum woodii</i>																		+
<i>Australina acuminata</i>										+								
<i>Ceropegia distincta</i>																		+
<i>Chamaesyce inaequilatera</i>															+			
<i>Chenopodium album</i> *															+			
<i>Chenopodium</i> sp. *															+			
<i>Chlorophytum krookianum</i>															+			
<i>Cineraria deltoidea</i>										+								
<i>Cineraria</i> sp.			+															
<i>Coccinia palmata</i> (C)											+							
<i>Coleotrype natalensis</i>						+												
<i>Colocasia antiquorum</i> *																+		
<i>Conyza bonariensis</i> *															+			
<i>Conyza ulmifolia</i>																+		
<i>Crassula sarmentosa</i>											+							
<i>Crotalaria grantiana</i>															+			
<i>Crotalaria virgulata</i>															+			
<i>Ctenomeria capensis</i> (C)										+								

* Alien and naturalised species

** (C) - Sedge; (F) - Forb; (Cl) - Climber; (G) - Grass;
 (R) - Reed; (GEO) - Geophyte; (P) - Fern; (X) - Xerophyte
 (S) - Shrub; (SU) - Undershrub; (SL) - Shrublet; (T) - Tree;
 (/c) - Climbing form

APPENDIX—Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1
	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1
51. Forbs and geophytes (continued)																	
<i>Cucumis hirsutus</i> (C)																	+
<i>Desmodium tortuosum</i>													+				
<i>Dicliptera heterostegia</i> seedlings					+												
<i>Dietes iridioides</i>						+											
<i>Eichhornia crassipes</i> *												+					
<i>Emex australis</i> *									+								
<i>Eriosema kraussianum</i>																+	
<i>Eriosema</i> sp.																+	
<i>Eulophia speciosa</i>								+									
<i>Evolvulus alsinoides</i>														+			
<i>Felicia erigeroides</i>													+				
<i>Flaveria bidentis</i> *													+				
<i>Galactia tenuiflora</i>																	+
<i>Galopina tomentosa</i>													+				
<i>Geranium schlechteri</i>													+				
<i>Gerbera ambigua</i> seedlings														+			
<i>Gladiolus crassifolius</i>																	+
<i>Gloriosa superba</i>			+														
<i>Haemanthus</i> sp.					+												
<i>Helianthus</i> sp. *														+			
<i>Helichrysum acutatum</i>														+			
<i>Helichrysum ascendens</i>								+									
<i>Helichrysum miconiifolium</i>																+	
<i>Helichrysum oxyphyllum</i>														+			
<i>Heliotropium amplexicaule</i> *														+			
<i>Hermannia</i> sp.														+			
<i>Hibiscus aethiopicus</i>														+			
<i>Hypericum aethiopicum</i>														+			
<i>Hypochoeris radicata</i> *														+			
<i>Hypoestes forskalii</i>								+									
<i>Hypoxis hemerocallidea</i>															+		
<i>Hypoxis</i> sp.															+		
<i>Indigofera eriocarpa</i>																+	
<i>Indigofera grata</i>															+		
<i>Indigofera oxytropis</i>																+	
<i>Indigofera velutina</i>															+		
<i>Ipomoea ficifolia</i> (C)					+												
<i>Ipomoea obscura</i> (C)													+				
<i>Ipomoea nighthii</i> (C)										+							
<i>Justicia campylostemon</i> seedlings			+														
<i>Justicia campylostemon</i>			+														
<i>Justicia petiolaris</i>					+												
<i>Kniphofia laxiflora</i>																	+
<i>Kohautia virgata</i>															+		
<i>Lactuca capensis</i>															+		
<i>Lactuca serriola</i> *															+		
<i>Laportea grossa</i>			+														
<i>Lepidium</i> sp. *															+		
<i>Lepidium virginicum</i> *															+		
<i>Lobelia coronopifolia</i>																	+
<i>Lobelia</i> sp.																+	
<i>Lotus discolor</i>													+				
<i>Ludwigia octovalvis</i>														+			

* Alien and naturalised species

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APPENDIX — Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
51. Forbs and geophytes (continued)																		
<i>Macrotyloma maranguense</i>														+				
<i>Melanthera scandens</i>														+				
<i>Melhania didyma</i>															+			
<i>Merremia tridentata</i>															+			
<i>Mirabilis jalapa</i> *									+									
<i>Nicandra physalodes</i> *															+			
<i>Nidorella auriculata</i> seedlings															+			
<i>Nidorella</i> sp. seedlings															+			
<i>Nothoscordum inodorum</i> *								+										
<i>Oenothera parodiana</i> *															+			
<i>Orthosiphon suffrutescens</i>																		+
<i>Pentarrhinum insipidum</i> (C)			+															
<i>Peponium mackenii</i> (C)													+					
<i>Peucedanum capense</i>														+				
<i>Phyllanthus heterophyllus</i>																	+	
<i>Physalis angulata</i> *															+			
<i>Physalis viscosa</i> seedlings *																+		
<i>Polygonum salicifolium</i>														+				
<i>Raphionacme flanaganii</i> (C)						+												
<i>Raphionacme galpinii</i> (C)															+			
<i>Rhynchosia nervosa</i>															+			
<i>Rubia cordifolia</i>		+																
<i>Rumex crispus</i> *															+			
<i>Rumex</i> sp. *								+										
<i>Sarcostemma viminalis</i> (C)						+												
<i>Schistostephium rotundifolium</i>														+				
<i>Schizoglossum cordifolium</i>																+		
<i>Schkuhria pinnata</i> *															+			
<i>Sebaea sedoides</i>																		+
<i>Senecio chrysocoma</i> seedlings									+									
<i>Senecio coronatus</i>																	+	
<i>Senecio deltoideus</i>					+													
<i>Senecio oxyodontus</i>															+			
<i>Senecio</i> sp. seedlings															+			
<i>Sida cordifolia</i>															+			
<i>Sida rhombifolia</i> seedlings															+			
<i>Solanum incanum</i>														+				
<i>Sonchus dregeanus</i>									+									
<i>Sonchus</i> sp. seedlings															+			
<i>Spermacoce natalensis</i>																		+
<i>Stachytarpheta indica</i> *									+									
<i>Streptocarpus prolixus</i>						+												
<i>Striga asiatica</i>														+				
<i>Talinum cafferum</i>								+										
<i>Tephrosia capensis</i>																	+	
<i>Tephrosia longipes</i>														+				
<i>Tetragonia tetragonoides</i>													+					
<i>Thesium natalense</i>																+		
<i>Thesium</i> sp.									+									
<i>Thunbergia alata</i>									+									
<i>Tithonia diversifolia</i> sapling *														+				
<i>Tithonia diversifolia</i> seedlings *														+				

* Alien and naturalised species

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APPENDIX — Phytosociological classification of the vegetation of municipal Durban (synoptic table) (continued)

Community number	1 1 1 1 1 1 1 1 1 1																	
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
51. Forbs and geophytes(continued)																		
<i>Tolpis capensis</i>																+		
<i>Trachyandra asperata</i>																		+
<i>Tradescantia virginiana</i> *		+																
<i>Tragia okanyua</i>									+									
<i>Tragia</i> sp.											+							
<i>Tropaeolum majus</i> *												+						
<i>Orospermum picroides</i> *													+					
<i>Verbena tenuisecta</i> *													+					
<i>Vernonia</i> sp.																	+	
<i>Vigna unguiculata</i>													+					
<i>Wahlenbergia dinteri</i>													+					
<i>Waltheria indica</i>													+					
<i>Watsonia densiflora</i>																	+	
<i>Withania somnifera</i> *													+					
52. Creepers																		
<i>Cynanchum schistoglossum</i>							+			+						1		
<i>Secamone filiformis</i>							+		+	+								
<i>Adenia gummifera</i>										+	+							
<i>Ceratiosicyos laevis</i>																1		
<i>Pereskia aculeata</i> sapling *							+			+								
<i>Capparis brassii</i> seedlings							+											
<i>Capparis</i> sp.											+							
<i>Cardiospermum grandiflorum</i> seedlings *							+											
<i>Cleomatis brachiata</i>												+						
<i>Dioscorea crinita</i>							+											
<i>Flagellaria guineensis</i> seedlings								+										
<i>Gerrardanthus tomentosus</i>							+											
<i>Myrsiphyllum asparagoides</i>									+	+								
<i>Protasparagus natalensis</i>													+					
<i>Protasparagus plumosus</i>									+									
<i>Protasparagus setaceus</i>											+							
<i>Protasparagus virgatus</i> seedlings							+											
<i>Secamone gerrardii</i>								+										
<i>Secamone parvifolia</i>									+									

* Alien and naturalised species

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Mpeke, Mrs E.N. General Assistant I	Viljoen, D.M. N.D. (Hort.) Senior Research Technician
Mtsetwa, A.M. Foreman I	Yekiso, S.M. General Assistant II

Adonis, J.J.M. General Assistant, Cleaning Services	Fredericks, Miss N.C.E. General Assistant
Arends, Miss L.D. Assistant, Plant Recording	Geduldts, D.C. Engraver
Basson, W. Head, Cleaning Services	Grace, T. Storeman/Sen. Administration Clerk, Plant Re-
De Jonge, Miss K. Typist	cording
De Kock, Mrs M.E. General Assistant, Cleaning Services	Haynie, R. General Assistant, Workshop
Ficks, T.E. Driver	Jacobs, A.P. Information Officer

CENTRAL

Jacobs, F.H. General Assistant. Stores
 Jacobs, K.C. Factotum
 Jansen, K.J. Driver
 Labuschagne, Mrs C.E. B.Sc. (Hon.) Education Officer
 Marent, Mrs H.C. Sen. Admin. Clerk, Plant Recording

McLean, N.S. General Assistant, Workshop
 Newman, W. Driver, Workshop
 Nicoll, Mrs. R.C. Senior Administration Clerk
 Trautman, C.E. Artisan/Supervisor, Workshop
 Williams, W.P. Foreman. Drivers

GARDEN

Adonis, A. General Assistant. Ericas
 Adams, H. General Assistant. New development
 Balabala, L. General Assistant. Dell
 Benjamin, R.C.J. Foreman. Annuals
 Boonzaaier, I. General Assistant. General garden
 Booysen, J.D. General Assistant. Annuals
 Bowler, J.H. Foreman. New development
 Bowler, M.A. General Assistant. Annuals
 Claasens, D. General Assistant. New development
 Crowie, H.R. General Assistant. General garden
 Crowie, R.W. Foreman. General garden
 Hendricks, S. General Assistant. Proteas
 Jansen, W. General Assistant. Annuals
 Jenkins, A. General Assistant. New development
 Johnson, J. General Assistant. Annuals
 Julius, J.A. Foreman. Dell
 Lewis, D.P. General Assistant. Proteas
 Lewis, P.S. General Assistant. Proteas
 Loft, G.E. General Assistant. Proteas

Lukas, K. General Assistant. General garden
 Manuel, D.R. General Assistant. Annuals
 Maxwell, P.E. General Assistant. New development
 McKlein, P. General Assistant. Dell
 Morris, J.N.M. General Assistant. Proteas
 Palmer, I. General Assistant. General garden
 Petersen, A. General Assistant. Cycads
 Philander, N. General Assistant. New development
 Pietersen, J. General Assistant. New development
 Plaatjies, S.D. General Assistant. Proteas
 Ruiters, M. General Assistant. New development
 Sampson, D. General Assistant. Dell
 Sampson, R. General Assistant. General garden
 Solomons, E.A. General Assistant. Proteas
 Solomons, K.J. General Assistant. Proteas
 Van der Westhuizen, A.J. Foreman. Proteas
 Van Rooy, K. General Assistant. Annuals
 Williams, M.L.J. General Assistant. New development

ESTATE

Le Roux, P.H. Chief Research Technician. Estate Manager

Abrahams, M. General Assistant. Estate & Trails
 Adams, J. General Assistant. Estate & Trails
 Adonis, S.J. General Assistant. Aliens
 Alfreds, M. General Assistant. Aliens
 Andrews, M.M. General Assistant. Estate & Trails
 Baadjies, I. General Assistant. Estate & Trails
 Bezuidenhout, A.K. General Assistant. General maintenance
 Bouwers, G.G. General Assistant. Construction
 Button, J. General Assistant. Estate & Trails
 Claasen, F. General Assistant. Aliens
 Dollie, Y. General Assistant. Estate & Trails
 Fienies, C. General Assistant. General maintenance
 Filand, A.J. General Assistant. Estate & Trails
 Geswind, A.J. General Assistant. Lawnmowers
 Grootboom, C.J. General Assistant. Construction
 Hendricks, M. General Assistant. Estate & Trails
 Hope, C. General Assistant. Construction
 Isaacs, M. General Assistant. Aliens
 Jackson, P. General Assistant. Lawnmowers
 Jacobs, M.D. General Assistant. Estate & Trails
 Jaftha, R. General Assistant. General maintenance
 Jaftha, W.R. General Assistant. Construction

Kayster, G.J. Foreman. Construction
 Kuscus, G.W. Foreman. General maintenance
 Matthews, I.N. General Assistant. Estate & Trails
 Mathews, N. General Assistant. Aliens
 McLean, A. General Assistant. Aliens
 McLean, N. General Assistant. Aliens
 Mitchells, G. Foreman. Estate & Trails
 Mitchells, R. General Assistant. Aliens
 Motaung, J. General Assistant. Estate & Trails
 Petersen, J. General Assistant. Aliens
 Petersen, N.H. General Assistant. Construction
 Plaatjies, D. General Assistant. Aliens
 Plaatjies, M.P. General Assistant. Estate & Trails
 Reed, T.W. General Assistant. Estate & Trails
 Rhode, W.C. General Assistant. Estate & Trails
 Sampson, J. Foreman, Aliens
 Sampson, J.J. General Assistant. Lawnmowers
 Snyders, S.G. General Assistant. Lawnmowers
 Solomons, G. General Assistant. Aliens
 Solomons, S. General Assistant. Construction
 Spiver, P. General Assistant. Aliens
 Van der Meulen, C.A. General Assistant. Construction
 Van Gusling, E.J. Foreman. Lawnmowers

NURSERY

Saunders, R.C. N.T.C. III (Hort.) Chief Research Technician. Head: Nursery

Adams, H. Foreman. Plant utilization	Kettledas, P.G. General Assistant. Nurseryman
Adonis, M. General Assistant. Nurseryman	King, O. General Assistant. Nurseryman
Apolis, A. General Assistant	Koma, B. General Assistant. Succulents
August, C. General Assistant. Seed room	Kotze, F.G. N.T.C. III (Hort.). Principal Research Technician
Berman, R.C. Security	Lawrence, E. General Assistant
Britz, R.M. N.D. (Forestry). Principal Research Technician. Head: Security	Lewin, T.B. General Assistant. Nurseryman
Carrol, R.R. General Assistant	Manuel, I.P. Foreman. Seed room
Daniels, A. General Assistant. Plant utilization	Marthinus, E. General Assistant. Succulents
Daids, M. General Assistant. Senior Nurseryman	Mulder, G.R. General Assistant. Nurseryman
Daids, M. General Assistant. Seed room	Notten, Miss A.L. Student (Temporary)
Daids, M.I. General Assistant. Senior Nurseryman	Pick, Miss U.M. General Assistant. Seed room
Daids, N. General Assistant. Nurseryman	Powrie, Miss F.J. B.Sc. (Hon.) N.D. (Hort.), Senior Research Technician
Duncan, G.D. N.D. (Hort.). Principal Research Technician	Rudolph, A. Security
Eksteen, M. General Assistant. Succulents	Sardien, T.P. General Assistant. Group Leader, succulents
Erasmus, S. Security	Sauls, C.J. General Assistant. Nurseryman
Francis, J. General Assistant. Plant utilization	Siljeur, H.V. General Assistant. Security
Goliath, Mrs L. General Assistant. Seed room	Smith, D. General Assistant
Gould, Mrs M. N.D. (Hort.). Senior Research Technician	Solomons, T. Foreman. Security
Hendricks, B.D. General Assistant. Succulents	Tamboer, J.S. Foreman. Nursery
Hitchcock, A.N. N.D. (Hort.), N.H.D. (Hort.). Senior Research Technician	Thomas, Mrs M.L. Senior Research Technician
Jacobs, C.W. General Assistant. Nurseryman	Van der Walt, Mrs L.E. N.D. (Hort.). Research Technician
Jacobs, D.G. Foreman. Plant utilization	Van Jaarsveld, E.J. M.Sc. N.D. (Hort.). Chief Research Technician
Jacobs, E.C. General Assistant. Seed room	Van Rooyen, Miss S. General Assistant. Seed room
Jacobs, H.C. Security	Van Schalkwyk, J. General Assistant. Succulents
Jamieson, Mrs H.G. N.D. (Parks & Recreation). Research Technician	Von Somnitz, Miss B.D. N.D. (Hort.). Kirstenbosch Scholar (Temporary)
January, C. Security	Williams, G.C. General Assistant. Security
January, P.C. General Assistant. Plant utilization	
Juta, E.C. General Assistant. Plant utilization	

LOWVELD—NELSPRUIT

Kluge, J.P. B.Sc. Hons, T.H.O.D. Chief Research Technician

Froneman, W.C. N.D. (Nature Conservation & Management), N.D. (Parks & Recreation Admin.), N.T.C. III (Hort.). Principal Research Technician	Ngomane, S. General Assistant
Hurter, P.J.H. B.Sc. Research Technician	Ngqani, Mrs L.S. General Assistant
Khoza, D.E. General Assistant	Ngwengoma, P.N. General Assistant
Khoza, F.D. General Assistant	Ngwenya, P.S. General Assistant
Khumalo, N.S. General Assistant	Ngwenyama, K.A. General Assistant
Khumalo, S.S. General Assistant	Ngwenyama, M.M. General Assistant
Magagula, K.E. General Assistant	Nkosi, M.P. General Assistant
Magagula, N.R. General Assistant	Nkosi, Mrs P.B. General Assistant
Mahlalubane, F.J. General Assistant	Nkosi, Mrs S.L. General Assistant
Makamo, Mrs J.E. General Assistant	Nyathi, R.M. General Assistant
Makhubela, B.J. General Assistant	Shabangu, M.E. General Assistant
Mantseke, N.A. General Assistant	Shabangu, S.L. General Assistant
Maqungo, Miss V.L.B. General Assistant	Shabangu, W.N. General Assistant
Mazibuko, F.E. General Assistant	Shawe, S.A. Foreman
Mdhuli, M.B. General Assistant	Sibule, B.F. General Assistant
Mdluli, M.E. General Assistant	Sibure, M.E. General Assistant
Mdluli, S. General Assistant	Sibure, W.F. General Assistant
Mkhatshwa, Mrs N.S. General Assistant	Sigudla, B.M. General Assistant
Mteto, E.M. General Assistant	Soka, M.P. General Assistant
Muswili, K.J. General Assistant	Thabethe, S.S. General Assistant
	Van der Walt, Mrs G.A. Administration Clerk

NATAL NBG—PIETERMARITZBURG

Tarr, B.B. N.D. (Parks & Recreation Admin.), Advanced Dip. (Adult Education).
Chief Research Technician

Busani, M.A. Driver
Dladla, P. General Assistant I
Dlamini, N.S. General Assistant II. Nursery foreman
Dlungwane, R. Foreman
Gabuza, A. General Assistant II
Gates, Ms J.E. N.D. (Hort.), N.D. (Parks & Recreation Admin.). Sen. Horticulturist. Kniphofia, forest spp.
Kistner, H.A. N.D. (Hort.)
Mbense, A. General Assistant II. Machine operator
Mdluli, K. General Assistant I
Mkize, M. General Assistant I
Mncwabe, Ms A. General Assistant I
Mncwabe, P. General Assistant II
Mpangase, Z. General Assistant II

Mpulo, D.H. General Assistant I
Mthalane, A. General Assistant II
Mthembu, D. General Assistant I
Mtolo, C. General Assistant III. Team leader
Nkabini, A. General Assistant II
Nzakwe, W. General Assistant I
Radebe, A. General Assistant I
Van der Merwe, Ms M.E.H. Administration Clerk
Zimu, J. General Assistant II
Zimu, S. General Assistant I
Zondi, Ms B.P. General Assistant I
Zondo, Z. General Assistant II
Zuma, J. General Assistant I
Zuma, Ms K. General Assistant I

ORANGE FREE STATE NBG—BLOEMFONTEIN

Engelbrecht, B. N.D. (Hort.), N.D. (Parks & Recreation Management), N.D. (Forestry)
Chief Research Technician

Eysele, Mrs J.P. Senior Administration Clerk
Kokela, Mrs C.L. General Assistant I. Nursery
Lekhetso, M.J. General Assistant III. Maintenance
Lekhetso, T.S. General Assistant I. Nursery
Lumley, M.J. Principal Research Technician. Nursery
Mbolekwa, G.M. General Assistant I. Grass garden
Mbolekwa, L.M. General Assistant III. *Rhus*, display
Mofokeng, J.M. General Assistant II. Nursery
Mofokeng, M.B. General Assistant I. Entrance
Mohokare, J. Driver
Mohapi, Mrs M.A. General Assistant I. Cleaner
Mohapi, T.A. General Assistant III. Grower, nursery

Moima, K.H. Foreman I.
Moima, T.J. General Assistant I. Maintenance
Mopeli, M.J. General Assistant I. Bulb area
Moticoe, Mrs M.A. General Assistant I. Braai area
Nakanyane, R.B. General Assistant III. Pond, display area
Nakedi, N.J. General Assistant II. Estate paths
Olifant, D.M. General Assistant II. Kiosk area
Rampai, M.A. General Assistant I. Maintenance
Sebolai, P.R.A.N. General Assistant III. Nursery, tools maintenance
Semeyane, T.D. General Assistant II. Maintenance
Thaele, Mrs M.E. General Assistant II. Seed room nursery

PRETORIA NBG

Heilgendorff, J.P. N.H.D. (Hort.) Chief Research Technician

Baloi, R.F. General Assistant II
Baloyi, K.J. General Assistant II
Baloyi, S.J. Driver/Operator
Baloyi, S.M. Research Assistant
Chipi, S. Security Assistant
Chuma, S.J. Security Assistant
Dry, D.H. N.D. (Hort.) Chief Research Technician. Technical papers on horticulture and plants
Kemp, J. General Assistant I
Keyter, B.A. Senior Security Officer
Klapwijk, N.A. N.D. (Hort.), N.D. (Plant Prod.), N.D. (Diesel Fitting). First Research Technician. Proteas, southern part of Pretoria garden
Lephera, J. General Assistant II
Letsoalo, H.M. General Assistant I
Mabasa, J.R. Security Assistant
Mabasa, P.P. General Assistant II
Mabunda, Z.S. General Assistant II
Machika, S.M. General Assistant II
Mahlangu, J.J. General Assistant I

Makana, M.S. Driver/Operator
Makana, S.N. Foreman
Makana, T.J. General Assistant II
Makgopo, C.K. General Assistant II
Makhubela, D. Foreman
Makhubela, K.P. General Assistant II
Makoeng, P.T. General Assistant II
Makola, J. General Assistant I
Makola, L.M. General Assistant III. Tractor driver
Makua, E.G. General Assistant I
Malewa, D. General Assistant II
Malobola, L. General Assistant II
Malobola, M. General Assistant III
Maluleke, M.J. Security
Mametja, A. General Assistant II
Mariri, N.J. Factotum
Marule, P.M. General Assistant III. Tractor driver
Masango, M.G. General Assistant II
Mathabathe, D.S. General Assistant II
Matlala, S.M. General Assistant II

PRETORIA NBG

Matshika, S.P. General Assistant II
 Mnyangeni, L.D. General Assistant II
 Mogoru, M.F. General Assistant II
 Mogoru, S. General Assistant II
 Mohale, F.R. Foreman
 Mohale, J.N. General Assistant I
 Mokawe, N.R. General Assistant I
 Molefe, J.R. General Assistant III
 Molokomme, J. General Assistant I
 Molomo, S.E. General Assistant I
 Mononyane, J.B. General Assistant II
 Morifi L.J. General Assistant I
 Motshweni, V. General Assistant II
 Msisa, S.K. General Assistant II
 Mudau, R.T. General Assistant I
 Muhali, B. General Assistant II
 Niemandt, M. Artisan
 Nkambule, J. General Assistant I

Nkoane, J.M. General Assistant I
 Nkwana, F.N. Driver/Operator
 Noko, J.M. Research Assistant
 Noku, A.Y. General Assistant III. Tractor driver
 Ramakgaphola, A.M. General Assistant I
 Ramatsetse, P.M. Security Assistant
 Rampopana, A.M. General Assistant I
 Sete, L. Foreman
 Shirindi, J.R. General Assistant I
 Shilubane, E. Storeman Assistant
 Sithole, J. General Assistant I
 Strydom, D.J.F. N.T.C. III (Hort.), N.D. (Parks & Rec. Management), Chief Research Technician. Cultivation of mass plants, northern part of Pretoria garden
 Swartz, Ms P. M.Sc. (Botany). Senior Horticulturist
 Tefu, P.R. General Assistant II
 Tloubatla, J.L. General Assistant I
 Tolo, P.K. General Assistant I

WITWATERSRAND NBG—WILROPARK

Chaplin, P.J. NTC Dip. (Hort.). Chief Research Technician

Behr, Miss C.M. B.Sc. Hons. Principal Research Technician. Education and information, phytosociological classification of the Witwatersrand garden
 Bongwe, N.W. General Assistant II. Machine operator
 Head, Mrs S.E. Senior Administration Clerk
 Khedzi, K.P. General Assistant II. Nursery
 Lukhwa, N.A. General Assistant I. Garden
 Luvhimbi, T.S. General Assistant I. Garden
 Majamane, Z.E. General Assistant I. Garden
 Mamosebo, M.A. General Assistant I. Garden
 Manyikana, T.M. General Assistant I. Garden
 Matsea, M.W. General Assistant I. Garden
 Mbulaheni, N.P. General Assistant II. Garden
 Mulibana, N.S. General Assistant II. Machine operator
 Mmola, Ms B.E. General Assistant I. Cleaner
 Ndou, A.P. General Assistant I. Garden
 Ndou, M.W. General Assistant II. Machine operator
 Ndwambi, N.W. General Assistant I. Garden

Ndzondo, N.L. General Assistant III. Clerical Assistant
 Nedambale, M.P. General Assistant III. Nursery
 Nematili, M.E. Driver
 Nematili, A.S. General Assistant III. Driver
 Nekhavhambe, S.P. General Assistant I. Garden
 Nenungwi, M.S. General Assistant I. Nursery
 Ngwenya, H.T. General Assistant I. Garden
 Rammela, N.N. General Assistant II. Machine operator
 Randima, M. General Assistant I. Garden
 Raphaelalani, V.S. General Assistant I. Nursery
 Ravhuhali, P.W. General Assistant I. Garden
 Steel, Miss B.S. N.D. (Nature Conservation), Dip. (Journalism). Research Technician
 Tebeile, Ms Z.M. General Assistant III. Clerical Assistant
 Tshisikule, G.M. General Assistant II. Garden
 Van der Westhuizen, Mrs S. M.Sc. Environmental Educationalist

RESEARCH DIRECTORATE

PRETORIA

Eloff, Prof. J.N. M.Sc. (Chemistry), D.Sc. (Plant Biochemistry). Director: Research
 Smith, G.F. Ph.D., F.L.S. Deputy Director: Research (plant systematics).
 Systematics of succulents and rosulate, petaloid monocots.

Meyer, Ms M.C. Dip. Gim. Man. Personal Secretary
 Saayman, Mrs E.J.L. M.Sc. Scientific Liaison Officer. Cytotaxonomy
 Arnold, T.H. Programme Leader: Data Management
 Donaldson, Dr J.S. Programme Leader: Conservation Biology (Cape Town)
 Du Plessis, Mrs H. Head: Research Support Services
 Koekemoer, Miss M. Curator: National Herbarium (Pretoria)
 Oliver, E.G.H. Curator: Stellenbosch Herbarium (Stellenbosch)
 Rourke, Dr J.P. Curator: Compton Herbarium (Cape Town)
 Rutherford, Dr M.C. Programme Leader: Stress Ecology (Rondebosch)
 Williams, Ms R. Curator: Natal Herbarium (Durban)

DATA MANAGEMENT—PRETORIA

Arnold, T.H. M.Sc. Assistant Director. Computer application especially in taxonomy

De Wet, Mrs B.C. B.Sc., B.A., H.D.L.S. Datametrician
Evenwel, Mrs E. Scientific Assistant

Harris, Mrs B.J. Scientific Assistant
Joubert, Mrs M.A.E. Senior Data Typist

COMPTON HERBARIUM—CAPE TOWN

Rourke, J.P. Ph.D., F.L.S. Specialist Scientist. Systematics of southern African Proteaceae, Stilbaceae

Cupido, Mrs C. General Assistant
Foster, Mrs S.E. Principal Typist
Holm, Mrs K. Scientific Assistant
Kurzweil, H. Ph.D. Scientist. Systematics of southern African terrestrial orchids
Manning, J.C. Ph.D. Scientist. Systematics of Iridaceae and Orchidaceae, cladistics and biogeography

Paterson-Jones, Mrs D.A. (née Snijman). Ph.D. Scientist. Systematics of Amaryllidaceae
Roux, J.P. N.T.C. (Hort.) M.Sc. Scientist. Systematics of Pteridophyta
Steiner, K.E. Ph.D. Specialist Scientist. Systematics of Scrophulariaceae and evolutionary interactions between oil-secreting flowers and oil-collecting bees

CONSERVATION BIOLOGY—CAPE TOWN

Donaldson, J.S. M.Sc. (Entomology), Ph.D. (Zoology). Assistant Director. Cycad biology, plant/insect interactions, conservation biology

Botha, P.A. N.H.D. (Hort.). Scientific Officer. Tissue culture research
Bowler, Mrs M. General Assistant
Brown, N.A.C. Ph.D. Specialist Scientist. Seed biology research, plant growth regulators
De Lange, J.H. B.Sc. (Hort.), M.Sc. (Plant Physiology), D.Sc. (Agric.) Specialist Scientist. Ecology, tissue culture, horticulture
Jita, Ms G.N. General Assistant
Köhly, Miss N. B.Sc. (Entomology & Microbiology). Scientific Officer. Scientific illustration

Leivers, S. B.Sc. (Microbiology, Plant Virology). Commercial tissue culture
McDonald, D.J. M.Sc. Scientist. Wetlands, salt marshes, coastal vegetation
Nänni, Ms I. B.Sc., H.E.D. Scientific Officer. Ecology, seed biology
Parenzee, Ms H.A. Administrative Assistant
Rebelo, A.G. Ph.D. (Zoology). Scientist. Conservation biology, biogeography
Scott, Mrs G. B.Sc. (Pharmacy), M.Sc. Scientific Officer. Plant secondary compounds, medicinal plants

NATAL HERBARIUM—DURBAN

Williams, Ms R. B.Sc. Hons, H.D.E. Scientific Officer

De Jager, P.J. M.Sc. Ethnobotanist.
Mbonambi, M.B. General Assistant. Gardener
Ngwenya, M.A. Herb. Assist. Identification, information

Noble, Mrs H-E. Administration Clerk.
Nzimande, S.B. General Assistant
Sikhakhane, T.B. Herbarium Assistant.

NATIONAL HERBARIUM—PRETORIA

Koekemoer, Miss M. M.Sc. Curator. Assistant Director. Taxonomy of Poaceae, Asteraceae; *Disparago* and related genera

Anderson, H.M. Ph.D. Scientist. Palaeobotany, palaeogeography
Anderson, J.M. Ph.D. Specialist Scientist. Palaeobotany, palaeogeography
Archer, R.H. M.Sc. Scientific Officer. Taxonomy of mainly Celastraceae, Euphorbiaceae
Bredenkamp, C.L. M.Sc. Scientific Officer. Taxonomy of *Vitex*, Rhamnaceae, Sterculiaceae and other related families

Burgoyne, P.M. B.Sc. (Hons). Scientific Assistant
Cloete, M. Dip. (Typing). Typist
Dreyer, Miss L.L. M.Sc. Scientific Officer. Taxonomy of mainly Geraniaceae
Fish, Mrs L. B.Sc. Scientific Officer. Poaceae. Identifications, collecting
Germishuizen, G. M.Sc. Scientist. Plant identifications, taxonomy of Polygonaceae, Fabaceae, Lorantheae, Viscaceae

- Glen, H.F. Ph.D. Scientist. Taxonomy of trees and succulents, especially *Aloe*, also cultivated plants
- Glen, Mrs R.P. M.Sc. Scientific Assistant. Ferns.
- Herman, P.P.J. M. Sc. Scientific Officer. Identifications, Rubiaceae—Asteraceae, Flora of Transvaal
- Heymann, Mrs M.Z. T.E. Dip. Scientific Assistant
- Jordaan, Mrs M. B.Sc. Scientific Officer. Taxonomy of Casuarinaceae—Connaraceae
- Lephaka, M.G. Scientific Assistant. Parcelling and pressing
- Makgakga, M.C. General Assistant
- Makgakga, S.K. Scientific Assistant. Mounting and filing of herbarium specimens
- Meyer, J.J. N.D. (Teaching). Scientific Assistant
- Meyer, N.L. B.Sc. (Hons). Scientific Officer. Taxonomy of Liliaceae
- Perold, Mrs S.M. D.Sc. Scientist. Taxonomy of Ricciaceae (Hepaticae)
- Phahla, T.J. Scientific Assistant. Mounting and filing of herbarium specimens
- Ready, Mrs J.A. N.D. (Hort.) Scientific Assistant
- Reid, Miss C. M.Sc. Scientist. Monocotyledons. Taxonomy of Cyperaceae
- Retief, Miss E. M.Sc. Scientist. Pollen studies of Boraginaceae. Taxonomy of Boraginaceae, Verbenaceae, Lamiaceae, Scrophulariaceae, Acanthaceae
- Rossouw, G.L. Scientific Assistant
- Smithies, Mrs S.J. M.Sc. Senior Scientific Officer. Taxonomy of mainly Scrophulariaceae, Selaginaceae, Lobeliaceae
- Strohmaier, Mrs S.M. T.E. Dip. Scientific Assistant
- Van Rooy, J. M.Sc. Scientist. Taxonomy and biogeography of mosses
- Van Wyk, Mrs C.M. M.Sc. Scientist. *Melolobium*, *Pelargonium*. Taxonomy of Rutaceae, Thymelaeaceae, Apiaceae, Ericaceae
- Veldman, Mrs J.M. Administration Clerk
- Welman, Miss W.G. M.Sc. Scientist. Taxonomy of Convolvulaceae—Asteraceae

STELLENBOSCH HERBARIUM

Oliver, E.G.H. M.Sc. Curator. Scientist. Taxonomy of the Ericoideae (Ericaceae)

- Beyers, Mrs J.B.P. M.Sc. Scientist. Taxonomy of the Gnidiaceae (Thymelaeaceae)
- Davidse, Mrs E. Scientific Assistant
- Fellingham, Mrs A.C. B.Sc. Scientific Officer. Taxonomy of *Cliffortia* (Rosaceae)
- Leith, Mrs J. Administration Clerk

STRESS ECOLOGY—UCT RONDEBOSCH

Rutherford, M.C. Ph.D., Dip. Datamet. Programme Leader. Stress and disturbance ecology

- Davis, G.W. Ph.D. Scientist. Ecophysiology, resource modelling
- De Wit, D.M. Scientific Assistant
- Fritz, M.F. Scientific Assistant
- Hoffman, M.T. Ph.D. Scientist. Disturbance ecology, desertification, photography
- Hunter, Ms D.A. Administrative secretary
- Jagger, B.W. Scientific Assistant
- Midgley, G.F. M.Sc. Scientist. Plant stress physiology/ecology
- ecology
- Musil, C.F. Ph.D. Scientist. Aquatic and terrestrial plant ecophysiology
- O'Callaghan, M.G. M.Sc. Scientist (Stellenbosch). Wetlands, salt marshes, coastal vegetation
- Powrie, L.W. M.Sc. Scientist. Karoo ecology, education, computer programming/operations
- Wand, S.J.E. M.Sc. (Agric.) Scientific Officer. Ecophysiology

RESEARCH SUPPORT SERVICES—PRETORIA

Du Plessis, Mrs. H. M.Sc. Head of Cost Centre. Scientist. Cytogenetics

- Botha, Mrs A.G. Scientific Assistant. Anatomy
- Romanowski, Mrs A.J. Dip. (Photography). Industrial Technician (Photography). Scientific photography.
- Roux, Mrs W.J.G. Dip. (Private Secretary). Scientific Assistant. Graphic artist, biology
- Steyn, Miss C.C. Scientific Assistant. Anatomy
- Steyn, Mrs E.M.A. Ph.D. Scientist. Embryology

PUBLICATIONS BY THE STAFF

(1992-04-01—1993-03-31)

- ANDERSON, H.M. 1992. Anomalous cones on a specimen of *Encephalartos transvenosus*. *Veld & Flora* 78: 79.
- ARCHER, R.H. 1992. A new species of *Maytenus* (Celastraceae) from southern Natal and Transkei. *South African Journal of Botany* 58: 393–396.
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Guide for authors to Bothalia

This guide is updated when necessary and includes an index. **Important points and latest additions appear in bold type.**

Bothalia is named in honour of General Louis Botha, first Premier and Minister of Agriculture of the Union of South Africa. This house journal of the National Botanical Institute, Pretoria, is devoted to the furtherance of botanical science. The main fields covered are taxonomy, ecology, anatomy and cytology. Two parts of the journal and an index to contents, authors and subjects are published annually.

1 Editorial policy

Bothalia welcomes original papers dealing with flora and vegetation of southern Africa and related subjects. Full-length papers and short notes, as well as book reviews, are accepted. Manuscripts may be written in either English or Afrikaans.

Articles are assessed by referees, both local and overseas. Authors are welcome to suggest possible referees to judge their work. Authors are responsible for the factual correctness of their contributions. *Bothalia* maintains an editorial board (see title page) to ensure that international standards are upheld.

Hard copy of articles should preferably be accompanied by PC diskettes or stiffies.

2 Requirements for diskettes/stiffies

2.1 data must be IBM compatible and written in **MSWord 5.5 or in ASCII**.

2.2 a printout of the diskette should be supplied to indicate (**in pencil**) the necessary **page numbers**, underlining, paragraphs etc.

2.3 **tables need not be placed on the diskette—a clearly laid out hard copy is adequate.**

2.4 the diskette must have **double** line spacing.

2.5 do not justify lines.

2.6 do not break words, except hyphenated words.

2.7 all lines, headings, keys, etc., should start flush at the margin, therefore no indentations of any kind.

2.8 no italics, bold or underlined words. **Only MSS submitted in MSWord 5.5 should use formatting for bold and italics.**

2.9 paragraphs and headings are delineated by an extra line spacing (carriage return) and no indentation.

2.10 a hyphen is designated as one dash, with no space between the letter and the dash, e.g. ovate-lanceolate. See also 17.6.

2.11 an N-dash is typed as **three** hyphens with no space between the letter and the hyphen, e.g. **2—5** mm (typeset, it looks like this, 2–5 mm).

2.12 an M-dash is typed as **two** hyphens with no space between the letter and the hyphen, e.g. computers—what a blessing! (typeset, it looks like this, computers—what).

2.13 do not use a double space between words, after commas, full stops, colons, semicolons or exclamation marks.

2.14 use lower case x as a times sign, with one space on either side of the x, e.g. 2 × 3 mm.

2.15 use single (not double) opening and closing quotes, e.g. the so-called ‘stiffy’ refers to a rigid diskette.

2.16 keys—put only three leader dots before number and name of taxon (with **one space before** and **one space after** the first and last dot), regardless of how far or near the word is from the right margin, e.g. ... 1. R. ovata.

3 Requirements for a manuscript

3.1 Manuscripts should be typewritten on one side of good quality A4-size paper, double-spaced throughout (including abstract, tables, captions to figures, literature references, etc.) and have a margin of at least 30 mm all round. The original and **three** photocopies (preferably **photocopied on both sides** of the paper to reduce weight for postage) of all items, including text, illustrations, tables and lists should be submitted, and the author should retain a complete set of copies.

3.2 Papers should conform to the general style and layout of recent issues of *Bothalia* (from volume 17 onwards).

3.3 Material should be presented in the following sequence: Title page with title, name(s) of author(s), keywords, abstracts (in English and Afrikaans) and information that should be placed in a footnote on the title page, such as address(es) of author(s) and mention of granting agencies.

3.4 The sequence continues with Introduction and aims, Material and methods, Results, Interpretation (Discussion), Specimens examined (in revisions and monographs), Acknowledgements, References, Index of names (recommended for revisions dealing with more than about 15 species), Tables, Captions for figures and figures. In the case of short notes and book reviews, keywords and abstract are superfluous.

3.5 All pages must be numbered **by hand in pencil (not on the diskette or printout)** beginning with the title page to those with references, tables and captions to figures.

3.6 For notes on the use of hyphens and dashes see 2.10 to 2.12.

4 Author(s)

When there are several authors the covering letter should indicate clearly which of them is responsible for correspondence and, if possible, telephonically available while the article is being processed. The contact address, telephone number and fax number should be mentioned if they differ from those given on the letterhead.

5 Title

The title should be as concise and as informative as possible. In articles dealing with taxonomy or closely related subjects the family of the taxon under discussion (see also 13.2) should be mentioned in brackets but author citations should be omitted from plant names.

6 Keywords

Up to 10 keywords (or index terms) should be provided in English in alphabetical sequence. The following points should be borne in mind when selecting keywords:

6.1 keywords should be unambiguous, internationally acceptable words and not recently coined little-known words.

6.2 they should be in a noun form and verbs should be avoided.

6.3 they should not consist of an adjective alone; adjectives should be combined with nouns.

6.4 they should not contain prepositions.

6.5 the singular form should be used for processes and properties, e.g. evaporation.

6.6 the plural form should be used for physical objects, e.g. augers.

6.7 location (province and/or country); taxa (species, genus, family) and vegetation type (community, veld type, biome) should be used as keywords.

6.8 keywords should be selected hierarchically where possible, e.g. both family and species should be included.

6.9 they should include terms used in the title.

6.10 they should answer the following questions:

6.10.1 what is the *active concept* in the document (activity, operation or process).

6.10.2, what is the *passive concept* or object of the active process (item on which the activity, operation or process takes place).

6.10.3, what is the means of accomplishment or how is the active concept achieved (technique, method, apparatus, operation or process).

6.10.4 what is the environment in which the active concept takes place (medium, location).

6.10.5 what are the independent (controlled) and dependent variables?

6.11 questions 6.10.1 to 6.10.3 should preferably also be answered in the title.

7 Abstract

7.1 Abstracts of no more than 200 words should be provided in English and Afrikaans. Abstracts are of great importance and should convey the essence of the article.

7.2 They should refer to the geographical area concerned and, in taxonomic articles, mention the number of taxa treated. They should not contain information not appearing in the article.

7.3 In articles dealing with taxonomy or closely related subjects all taxa from the rank of genus downwards should be accompanied by their author citations.

7.4 Names of new taxa and new combinations should not be underlined. If the article deals with too many taxa, only the important ones should be mentioned.

8 Table of contents

A table of contents should be given for all articles longer than about 20 typed pages, unless they follow the strict format of a taxonomic revision.

9 Acknowledgements

Acknowledgements should be kept to the minimum compatible with the requirements of courtesy. Please give all the initials of the person(s) you are thanking.

10 Literature references

In text

10.1 Literature references in the text should be cited as follows: 'Jones & Smith (1986) stated...', or '...(Jones & Smith 1986)' or (Ellis 1988: 67) when giving a reference simply as authority for a statement. For treatment of literature references in taxonomic papers see 14.

10.2 When more than **two** authors are involved in the paper use the name of the first author followed by *et al.*

10.3 When referring to more than one literature reference, they should be arranged alphabetically according to author and separated by a semicolon, e.g. (Anon. 1981, 1984; Davis 1976; Nixon 1940).

10.4 Titles of books and names of journals should preferably not be mentioned in the text. If there is good reason for doing so, they should be treated as described in 10.12 & 10.13.

10.5 Personal communications are given only in the text, not in the list of references. Please add the person's full initials to identify the person more positively, e.g. C. Boucher pers. comm.

In References at end of article

10.6 References of the same author are arranged in chronological sequence.

10.7 Where two or more references by the same author are listed in succession, the author's name is repeated with every reference.

10.8 All publications referred to in the text, **including those mentioned in full in the treatment of correct names in taxonomic papers**, but no others, and no personal communications, are listed at the end of the manuscript under the heading References.

10.9 The references are arranged alphabetically according to authors and chronologically under each author, with a, b, c, etc. added to the year, if the author has published more than one work in a year.

10.10 If an author has published both on his own and as a senior author with others, the solo publications are listed first and after that, in strict alphabetical sequence, those published with one or more other authors.

10.11 Author names are typed in capitals.

10.12 Titles of journals and of books are written out in full and are underlined as follows: *Transactions of the Linnean Society of London* 5: 171–217, or *Biology and ecology of weeds*: 24.

10.13 Titles of books should be given as in *Taxonomic literature*, edn 2 by Stafleu & Cowan and names of journals as in the latest edition of *World list of scientific periodicals*.

10.14 Examples of references:

Collective book or Flora

BROWN, N.E. 1909. Asclepiadaceae. In W.T. Thiselton-Dyer, *Flora capensis* 6,2: 518–1036. Reeve, London.

CUNNINGHAM, A.B. 1989. Indigenous plant use: balancing human needs and resources. In B.J. Huntley, *Biotic diversity in southern Africa—concepts and conservation*: 93–106. Oxford University Press, Cape Town.

Book

DU TOIT, A.L. 1966. *Geology of South Africa*, 3rd edn, S.M. Houghton (ed.), Oliver & Boyd, London.

HUTCHINSON, J. 1946. *A botanist in southern Africa*. Gawthorn, London.

Journal

DAVIS, G. 1988. Description of a proteoid-restioid stand in Mesic Mountain Fynbos of the southwestern Cape and some aspects of its ecology. *Bothalia* 18: 279–287.

STEBBINS, G.L. Jr 1952. Aridity as a stimulus to plant evolution. *American Naturalist* 86: 35–44.

SMOOK, L. & GIBBS RUSSELL, G.E. 1985. Poaceae. *Memoirs of the Botanical Survey of South Africa* No. 51: 45–70.

In press, in preparation

TAYLOR, H.C. in press. *A reconnaissance of the vegetation of Rooiberg State Forest*. Technical Bulletin, Department of Forestry.

VOGEL, J.C. 1982. The age of the the Kuiseb river silt terrace at Homeb. *Palaeoecology of Africa* 15. In press.

WEISSER, P.J., GARLAND, J.F. & DREWS, B.K. in prep. Dune advancement 1937–1977 and preliminary vegetation succession chronology at Milazi Nature Reserve, Natal, South Africa. *Bothalia*.

Thesis

KRUGER, F.J. 1974. *The phytogeography and plant communities of the Jakkalsrivier Catchment*. M.Sc. (Forestry) thesis, University of Stellenbosch.

MUNDAY, J. 1980. *The genus Monechma Hochst. (Acanthaceae tribe Justiciae) in southern Africa*. M.Sc. thesis, University of the Witwatersrand, Johannesburg.

Miscellaneous paper, report, unpublished article, technical note, congress proceedings

ANON. no date. *Eetbare plante van die Wolkberg*. Botanical Research Unit, Grahamstown. Unpublished.

BAWDEN, M.G. & CARROL, D.M. 1968. *The land resources of Lesotho*. Land Resources Study No. 3, Land Resources Division, Directorate of Overseas Surveys, Tolworth.

BOUCHER, C. 1981. Contributions of the Botanical Research Institute. In A.E.F. Heydorn, *Proceedings of workshop research in Cape estuaries*: 105–107. National Research Institute for Oceanology, CSIR, Stellenbosch.

NATIONAL BUILDING RESEARCH INSTITUTE 1959. *Report of the committee on the protection of building timbers in South Africa against termites, woodboring beetles and fungi*, 2nd edn. CSIR Research Report No. 169.

11 Tables

11.1 Each table should be presented on a separate sheet and be assigned an Arabic numeral, i.e. the first table mentioned in the text is marked 'Table 1'.

11.2 In the captions of tables the word 'table' is written in capital letters. See recent numbers of *Bothalia* for the format required.

11.3 Avoid vertical lines, if at all possible. Tables can often be reduced in width by interchanging primary horizontal and vertical heads.

12 Figures

12.1 Figures should be planned to fit, after reduction, into a width of either 80, 118 or 165 mm, with a maximum vertical length of 230 mm. Allow space for the caption in the case of figures that will occupy a whole page.

12.2 Line drawings, including graphs and diagrams, should be in jet-black Indian ink, preferably on fine Felix Schoeller parole or similar board, 200 gsm, or tracing film. Lines should be bold enough and letters/symbols large enough to stand reduction.

12.3 It is recommended that drawings should be twice the size of the final reproduction.

12.4 Photographs should be of excellent quality on glossy paper with clear detail and moderate contrast, and they should be the same size as required in the journal.

12.5 Photograph mosaics should be submitted complete, the component photographs mounted neatly on a white flexible card base leaving a narrow gap of uniform width (2 mm) between each print. Note that grouping photographs of markedly divergent contrast results in poor reproductions.

12.6 Lettering and numbering on all figures should be done in lettraset, stencilling or a comparable method. If symbols are to be placed on a dark background it is recommended that black symbols are used on a small white disk ± 7 mm in diameter and placed **in the lower left hand corner** of the relevant photo.

12.7 If several illustrations are treated as components of a single composite figure they should be designated by **capital letters**.

12.8 Note that the word 'figure' should be written out in full, both in the text and the captions.

12.9 In the text the figure reference is then written as in the following example: 'The stamens (Figure 4A, B) are...'

12.10 In captions, 'figure' is written in capital letters. Magnification of figures should be given for the size as submitted.

12.11 **Scale bars or scale lines should be used on figures.**

12.12 In figures accompanying taxonomic papers, voucher specimens should be given in the relevant caption.

12.13 Figures are numbered consecutively with Arabic numerals **in the order they are referred to in the text**. These numbers, as well as the author's name and an indication of the top of the figure, must be written in soft pencil on the back of all figures.

12.14 Captions of figures must **not** be pasted under the photograph or drawing.

12.15 Authors should indicate **in pencil** in the text where they would like the figures to appear.

12.16 Authors wishing to have the originals of figures returned must inform the editor in the original covering letter and must mark each original 'To be returned to author'.

12.17 Authors wishing to use illustrations already published must obtain written permission before submitting the manuscript and inform the editor of this fact.

12.18 Captions for figures should be collected together and typed on a **separate sheet** headed *Captions for figures*.

12.19 It is strongly recommended that taxonomic articles include dot maps as figures to show the distribution of taxa. The dots used must be large enough to stand reduction to 80 mm (recommended size: lettraset 5 mm diameter).

12.20 Blank maps are available from the **bookshop, NBI Pretoria**.

13 Text

13.1 As a rule authors should use the names as listed by **T.H. Arnold & B.C. de Wet (eds)** in *Memoirs of the Botanical Survey of South Africa* No. 62.

13.2 Names of genera and infrageneric taxa are usually underlined, with the author citation (where relevant) not underlined. Exceptions include names of new taxa in the abstracts, correct names given in the synopsis or in paragraphs on species excluded from a given supraspecific group in taxonomic articles, in checklists and in indices, where the position is reversed, correct names not being underlined and synonyms underlined.

13.3 Names above generic level are not underlined.

13.4 In articles dealing with taxonomy and closely related subjects the complete scientific name of a plant (with author citation) should be given at the first mention in the text. The generic name should be abbreviated to the initial thereafter, except where intervening references to other genera with the same initial could cause confusion.

13.5 In normal text, Latin words are italicized, but in the synopsis of a species, Latin words such as *nom. nud.* are not italicized.

13.6 Names of authors of plant names should agree with the list **published by the Royal Botanic Gardens, Kew**, entitled, *Authors of plant names*, edited by R.K. Brummitt & C.E. Powell (1992).

13.7 Modern authors not included in the list should use their full name and initials when publishing new plant names. Other author names not in the list should be in agreement with the recommendations of the Code.

13.8 Names of authors of publications are written out in full except in the synonymy in taxonomic articles where they are treated like names of authors of plant names.

13.9 Names of plant collectors are underlined whenever they are linked to the number of a specimen. The collection number is also underlined, e.g. *Acocks 14407*.

13.10 Surnames beginning with 'De', 'Du' or 'Van' begin with a capital letter unless preceded by an initial.

13.11 For measurements use only units of the International System of Units (SI). Cm should not be used, only mm and/or m.

13.12 The use of '±' is preferred to c. or ca.

13.13 Numbers 'one' to 'nine' are spelled out in normal text, and from 10 onwards they are written in Arabic numerals.

13.14 In descriptions of plants, numerals are used throughout. Write 2.0–4.5 (not 2–4.5). When counting members write 2 or 3 (not 2–3) but 2–4.

13.15 Abbreviations should be used sparingly but consistently. No full stops are placed after abbreviations ending with the last letter of the full word (e.g. edition = edn; editor = ed.), after units of measure, after compass directions and after herbarium designations.

13.16 Apart from multi-access keys, indented keys should be used with couplets numbered 1a–1b, 2a–2b, etc. (without full stops thereafter).

13.17 Keys consisting of a single couplet have no numbering.

13.18 Manuscripts of keys should be presented as in the following example:

1a Leaves closely arranged on an elongated stem; a submerged aquatic with only the capitula exerted ... 1b. *E. setaceum* var. *pumilum*

1b Leaves in basal rosettes; stems suppressed; small marsh plants, ruderals or rarely aquatics:

2a Annuals, small, fast-growing pioneers, dying when the habitat dries up; capitula without coarse white setae; receptacles cylindrical:

3a Anthers white ... 2. *E. cinereum*

3b Anthers black ... 3. *E. nigrum*

2b Perennials, more robust plants; capitula sparsely to densely covered with short setae:

13.19 Herbarium voucher specimens should be referred to wherever possible, not only in taxonomic articles.

14 Species treatment in taxonomic papers

14.1 The procedure to be followed is illustrated in the example (17, 17.8), which should be referred to, because not all steps are described in full detail.

14.2 The correct name (not underlined) is to be followed by its author citation (underlined) and the full literature reference, with the name of the publication written out in full (not underlined).

14.3 Thereafter all literature references, including those of the synonyms, should only reflect author, page and year of publication, e.g. C.E. Hubb. in Kew Bulletin 15: 307 (1960); Boris *et al.*: 14 (1966); Boris: 89 (1967); Sims: t. 38 (1977); Sims: 67 (1980).

14.4 The description and the discussion should consist of paragraphs commencing, where possible, with italicized leader words such as *flowering time*, *diagnostic characters*, *distribution* and *habitat*.

14.5 When more than one species of a given genus is dealt with in a paper, the correct name of each species should be prefixed by a sequential number followed by a full stop, the first line of the paragraph to be indented. Intraspecific taxa are marked with small letters, e.g. 1b., 12c., etc.

14.6 Names of authors are written in the same way (see 13.1, 13.6), irrespective of whether the person in question is cited as the author of a plant name or of a publication.

14.7 The word 'figure' is written as 'fig.', and 't.' is used for both 'plate' and 'tablet'.

14.8 Literature references providing good illustrations of the species in question may be cited in a paragraph commencing with the word *Icones* followed by a colon. This

paragraph is given after the last paragraph of the synonymy, see 17.9.

15 Citation of specimens

15.1 Type specimen in synopsis: the following should be given (if available): country (if not in RSA), province, grid reference (at least for new taxa), locality as given by original collector, modern equivalent of collecting locality in square brackets (if relevant), **quarter-degree square**, date of collection (optional), collector's name and collecting number (both underlined).

15.2 The abbreviation *s.n.* (*sine numero*) is given after the name of a collector who usually assigned numbers to his collections but did not do so in the specimen in question. The herbaria in which the relevant type(s) are housed are indicated by means of the abbreviations given in the latest edition of *Index Herbariorum*.

15.3 The holotype (holo.) and its location are mentioned first, followed by a semicolon, the other herbaria are arranged alphabetically, separated by commas.

15.4 Authors should indicate by means of an exclamation mark (!) which of the types have been personally examined.

15.5 If only a photograph or microfiche was seen, write as follows: *Anon.* 422 (X, holo.—BOL, photo.!).

15.6 Lectotypes or neotypes should be chosen for correct names without a holotype. It is not necessary to lectotypify synonyms.

15.7 When a lectotype or a neotype are newly chosen this should be indicated by using the phrase 'here designated'. If reference is made to a previously selected lectotype or neotype, the name of the designating author and the literature reference should be given. In cases where no type was cited, and none has subsequently been nominated, this may be stated as 'not designated'.

15.8 In brief papers mentioning **only a few species and a few cited specimens** the specimens should be arranged according to the grid reference system: Provinces/countries (typed in capitals) should be cited in the following order: SWA/Namibia, Botswana, Transvaal, Orange Free State, Swaziland, Natal, Lesotho, Transkei and Cape.

15.9 Grid references should be cited in numerical sequence.

15.10 Locality records for specimens should preferably be given to within a quarter-degree square. Records from the same one-degree square are given in alphabetical order, i.e. (–AC) precedes (–AD), etc. Records from the same quarter-degree square are arranged alphabetically according to the collectors' names; the quarter-degree references must be repeated for each specimen cited.

15.11 The relevant international code of the herbaria in which a collection was seen should be given in brackets after the collection number; the codes are separated by commas. The following example will explain the procedure:

NATAL.—2731 (Louwsburg): 16 km E of Nongoma, (—DD), *Pelser 354* (BM, K, PRE); near Dwaarsrand, *Van der Merwe 4789* (BOL, M), 2829 (Harrismith); near Groothoek, (—AB), *Smith 234*; Koffiefontein, (—AB), *Taylor 720* (PRE); Cathedral Peak Forest Station, (—CC), *Marriot 74* (KMG); Wilgerfontein, *Roux 426*. Grid ref. unknown: Sterkstroom, *Strydom 12* (NBG).

15.12 For records from outside southern Africa authors should use degree squares without names, e.g.:

KENYA.—0136: Nairobi plains beyond race course, *Napier 485*.

15.13 Monographs and revisions: in the case of all major works of this nature it is assumed that the author has investigated the relevant material in all major herbaria and that he has provided the specimens seen with determinavit labels. It is assumed further that the author has submitted distribution maps for all relevant taxa and that the distribution has been described briefly in words in the text. Under the heading 'Vouchers' no more than five specimens should be cited, indicating merely the collector and the collector's number (both underlined). Specimens are alphabetically arranged according to collector's name. If more than one specimen by the same collector is cited, they are arranged numerically and separated by a **comma**. The purpose of the cited specimens is not to indicate distribution but to convey the author's concept of the taxon in question.

15.14 The herbaria in which the specimens are housed are indicated by means of the abbreviation given in the latest edition of *Index Herbariorum*. They are given between brackets, arranged alphabetically and separated by commas behind every specimen as in the following example:

Vouchers: *Fisher 840* (NH, NU, PRE); *Flanagan 831* (GRA, PRE), 840 (NH, PRE); *Marloth 4926* (PRE, STE); *Schelte 6161, 6163, 6405* (BOL); *Schlechter 4451* (BM, BOL, GRA, K, PRE).

15.15 If long lists of specimens are given, they **must** be listed together **before Acknowledgements** under the heading *Specimens examined*. They are arranged alphabetically by the collector's name and then numerically for each collector. The species is indicated in brackets by the number that was assigned to it in the text and any infra-specific taxa by a small letter. If more than one genus is dealt with in a given article, the first species of the first genus mentioned is indicated as 1.1. This is followed by the international herbarium designation. Note that the name of the collector and the collection number are underlined:

Acoccks 12497 (2.1b) BM, K, PRE; *14724* (1.13a) BOL, K, P. *Archer 1507* (1.4) BM, G. *Burchell 2847* (2.8c) MB, K. *Burman 2401* (3.3) MO, S. *Burt 789* (2.6) B, KMG, STE.

16 Synonyms

16.1 In a monograph or a revision covering all of southern Africa, all synonyms based on types of southern African origin, or used in southern African literature, should be included.

16.2 Illegitimate names are designated by *nom. illeg.* after the reference, followed by *non* with the author and date, if there is an earlier homonym.

16.3 *Nomina nuda* (*nom. nud.*) and **invalidly published** names are excluded unless there is a special reason to cite

them, for example if they have been used in prominent publications.

16.4 In normal text Latin words are italicized, but in the synopsis of a species Latin words such as *nom. nud.* are not italicized.

16.5 Synonyms should be arranged chronologically into groups of nomenclatural synonyms, i.e. synonyms based on the same type, and the groups should be arranged chronologically by basionyms, except for the basionym of the correct name which is dealt with in the paragraph directly after that of the correct name.

16.6 When a generic name is repeated in a given synonymy it should be abbreviated to the initial except where intervening references to other genera with the same initial could cause confusion.

17 Description and example of species treatment

17.1 Descriptions of all taxa of higher plants should, where possible, follow the sequence: Habit; sexuality; underground parts (if relevant). *Indumentum* (if it can be easily described for the whole plant). *Stems/branches*. *Bark*. *Leaves*: arrangement, petiole absent/present, pubescence; blade: shape, size, apex, base, margin; midrib: above/below, texture, colour; petiole; stipules. *Inflorescence*: type, shape, position; bracts/bracteoles. *Flowers*: shape, sex. *Receptacle*. *Calyx*. *Corolla*. *Disc*. *Androecium*. *Gynoecium*. *Fruit*. *Seeds*. *Chromosome number*. Figure (word written out in full) number.

17.2 As a rule shape should be given before measurements.

17.3 In general, if an organ has more than one of the parts being described, use the plural, otherwise use the singular, for example, petals of a flower but blade of a leaf.

17.4 Language must be as concise as possible, using participles instead of verbs.

17.5 Dimension ranges should be cited as in 17.9.

17.6 Care must be exercised in the use of dashes and hyphens: a *hyphen* is a short stroke joining two syllables of a word, e.g. ovate-lanceolate or sea-green, with no space between the letter and the stroke; an *N-dash* (*en*) is a longer stroke commonly used instead of the word 'to' between numerals, '2–5 mm long' (do not use it between words but rather use the word 'to', e.g. 'ovate to lanceolate'); it is produced by typing 3 hyphens next to each other; and an *M-dash* (*em*) is a stroke longer than an N-dash and is used variously, e.g. in front of a subspecific epithet in stead of the full species name; it is produced by typing 2 hyphens next to one another.

17.7 The use of '±' is preferred to c. or ca when describing shape, measurements, dimensions, etc.

17.8 **The decimal point replaces the comma in all units of measurement**, e.g. leaves 1.0–1.5 mm long.

17.9 Example:

1. *Bequaertiodendron magalismontanum* (Sond.) Heine & Hemsl. in Kew Bulletin: 307 (1960); Codd: 72 (1964); Elsdon: 75 (1980). Type: Transvaal, Magaliesberg, Zeyher 1849 (S, holo.-BOL, photo!).

Chrysophyllum magalismontanum Sond.: 721 (1850); Harv.: 812 (1867); Engl.: 434 (1904); Bottmar: 34 (1919). *Zeyherella magalismontanum* (Sond.) Aubrév. & Pellegr.: 105 (1958); Justin: (1973).

Chrysophyllum argyrophyllum Hiern: 721 (1850); Engl.: 43 (1904). *Boivinella argyrophylla* (Hiern) Aubrév. & Pellegr.: 37 (1958); Justin: 98 (1973). Types: Angola, Welwitsch 4828 (BM!, lecto., here designated; PRE!); Angola, Welwitsch 4872 (BM!).

Chrysophyllum wilmsii Engl.: 4, t. 16 (1904); Masonet: 77 (1923); Woodson: 244 (1937). *Boivinella wilmsii* (Engl.) Aubrév. & Pellegr.: 39 (1958); Justin: 99 (1973). Type: Transvaal, Magoebaskloof, Wilms 1812 (B, holo.; K!, P!, lecto., designated by Aubrév. & Pellegr.: 38 (1958), PRE!, S!, W!, Z!).

Bequaertiodendron fruticosa De Wild.: 37 (1923), non Bonpland: 590 (1823); Bakker: 167 (1929); Fries: 302 (1938); Davy: 640 (1954); Breitenbach: 117 (1959); Clausen: 720 (1968); Pelmer: 34 (1969). Type: Transvaal, Tzaneen Dist., Granville 3665 (K, holo.; G!, P!, PRE!, S!).

Bequaertiodendron fragrans auct. non Oldemann: Glover: 149, t. 19 (1915); Henkel: 226 (1934); Stapleton: 6 (1954).

Icones: Harv.: 812 (1867); Henkel: t. 84 (1934?); Codd: 73 (1964); Palmer: 35 (1969).

Woody perennial; main branches up to 0.4 m long, erect or decumbent, grey woolly-felted, leafy. *Leaves linear to oblanceolate, 3–10(–23) × 1.0–1.5(–4.0) mm*, obtuse, base broad, half-clasping. *Heads* heterogamous, campanulate, 7–8 × 5 mm, solitary, sessile at tip of axillary shoots; involucre bracts in 5 or 6 series, inner exceeding flowers, tips subopaque, white, very acute. *Receptacle* nearly smooth. *Flowers* ± 23–30, 7–11 male, 16–21 bisexual, yellow, tipped pink. *Achenes* ± 0.75 mm long, elliptic. *Pappus* bristles very many, equalling corolla, scabridulous. *Chromosome number*: 2n = 22. Figure 23B.

18 New taxa

18.1 The name of a new taxon must be accompanied by at least a Latin diagnosis. Authors should not provide full-length Latin descriptions unless they have the required expertise in Latin at their disposal.

18.2 It is recommended that descriptions of new taxa be accompanied by a good illustration (line drawing or photograph) and a distribution map.

18.3 Example:

109. *Helichrysum jubilatatum* Hilliard, sp. nov. *H. alsinoidei* DC. affinis, sed foliis ellipticis (nec spatulatis), inflorescentiis compositis a foliis non circumcinctis, floribus femineis numero quasi dimidium hermaphroditiorum aequantibus (nec capitulis homogamis vel floribus femineis 1–3 tantum) distinguitur.

Herba annua e basi ramosa; caules erecti vel decumbentes, 100–250 mm longi, tenuiter albo-lanati, remote foliati. *Folia* plerumque 8–30 × 5–15 mm, sub capitulis minor, elliptica vel oblanceolata, obtusa vel acuta, mucronata, basi semi-amplexicauli, utrinque cano-lanato-arachnoidea. *Capitula* heterogama, campanulata, 3.5–4.0 × 2.5 mm, pro parte maxima in paniculas cymosas terminales aggregata; capitula subterminalia interdum solita-

ria vel 2–3 ad apices ramulorum nudorum ad 30 mm longorum. *Bractae involucreales* 5-seriatae, gradatae, exteriores pellucidae, pallide stramineae, dorso lanatae, seriebus duabus interioribus subaequalibus et flores quasi aequantibus, apicibus obtusis opacis niveis vix radiantibus. *Receptaculum* fere laeve. *Flores* ± 35–41. *Achenia* 0.75 mm longa, pilis myxogenis praedita. *Pappi* setae multae, corollam aequantes, apicibus scabridis, basibus non cohaerentibus.

TYPE.—Cape, 2817 (Vioolsdrif): Richtersveld, (–CC), ± 5 miles E of Lekkersing on road to Stinkfontein, kloof in hill south of road, annual, disc whitish, 7-II-1962, *Nordenstam* 1823 (S, holo.; E, NH, PRE).

19 Proofs

Only page proofs are normally sent to authors. They should be corrected in red ink and be returned to the editor as soon as possible.

20 Reprints

Authors receive 100 reprints free. If there is more than one author, this number will have to be shared between them.

21 Documents consulted

Guides to authors of the following publications were made use of in the compilation of the present guide: *Annals of the Missouri Botanic Garden*, *Botanical Journal of the Linnean Society*, *Flora of Australia*, *Smithsonian Contributions to Botany*, *South African Journal of Botany* (including instructions to authors of taxonomic papers), *South African Journal of Science*.

22 Address of editor

Manuscripts should be submitted to: The Editor, *Bothalia*, National Botanical Institute, Private Bag X101, Pretoria 0001.

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